



Missouri Department of Natural Resources

Biological and Habitat Assessment Study Report

Joplin Area Highly Modified Headwater Streams Jasper, Newton, Barry, and Dade Counties

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1.0 Introduction

The Missouri Department of Natural Resources' (**MDNR**), Environmental Services Program's (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological and habitat assessment of highly modified and, until recently, unclassified headwater streams in the city of Joplin.

As part of a cooperative effort with the Missouri Department of Conservation (**MDC**) to identify reference, or high quality, reaches for Missouri streams to use as "yardsticks" for assessing stream quality, it is important to evaluate habitat conditions. This study attempts to compare biological communities in streams having modified habitats with biological communities in candidate reference streams from the same Ecological Drainage Unit (**EDU**). An EDU is a region where biological communities and habitat conditions are expected to be similar barring artificial habitat alteration.

Two headwater streams were sampled in Joplin: a tributary (Trib.) to Silver Creek and a Trib. to Joplin Creek as well as one station on a small Trib. to that stream. Among these two streams extreme habitat alteration exists at most stations and at variable degrees of alteration at others. The most extreme example of habitat alteration is where the streambed and banks have been completely paved and no natural substrate, bank structure, or riparian zone vegetative cover remains.

Candidate reference streams were chosen throughout the EDU for comparison with the Joplin study streams. These streams were chosen based on criteria similar to those used to establish biological criteria reference (**BIOREF**) streams (MDNR 2002). To attain reference quality, a stream must have a minimum degree of impact with the exceptions of being previously unclassified and as similar in size to the Joplin headwater study streams as possible.

1.1 Purpose

The purpose of this study is to determine if the Joplin headwater study streams' macroinvertebrate communities are impaired and, if so, demonstrate the relationship with the modified habitats. Another goal of this study is to provide experience in the selection of headwater reference streams.

1.2 Objectives

- Determine if the macroinvertebrate communities of the Joplin headwater streams are impaired.
- Determine the habitat characteristics of the Joplin headwater streams and the candidate reference streams.
- Determine the relationship between the altered habitats of Joplin headwater streams and potential impairments to macroinvertebrate communities.

1.3 Tasks

- Conduct a biological assessment of the macroinvertebrate communities of the Joplin headwater streams and the candidate reference streams.
- Conduct a habitat assessment of the Joplin headwater streams and the candidate reference streams.
- Conduct a water quality assessment of the Joplin headwater streams and the candidate reference streams.

1.4 Null Hypotheses

- Macroinvertebrate assemblages are similar between Joplin area study streams and candidate reference streams.
- Macroinvertebrate assemblages are similar between study stream stations with modified habitats and stream stations with unmodified habitats.
- Macroinvertebrate assemblages are similar between Trib. to Joplin Creek stream segments and Trib. to Silver Creek stations.
- Macroinvertebrate assemblages will not differ between the two sample seasons.
- There will be no habitat difference between modified and unmodified stream segments.

2.0 Study Area

Both study streams are entirely within the city limits of Joplin. The Trib. of Silver Creek originates northeast of the intersection of I-44 and Rangeline. It then flows west-southwest and crosses I-44 at the Rangeline interchange. Its confluence with Silver Creek is just west of Rangeline between I-44 and 44th St. The Trib. of Silver Creek flows through primarily urban landscape over a variety of habitat conditions ranging from all natural substrate and banks with good riparian cover to completely paved bottom and bank.

The Trib. of Joplin Creek originates approximately north of 25th St. and east of Stephens Blvd. It flows predominantly northwest to its confluence with Joplin Creek near the intersection of 5th St. and Murphy Blvd. The Trib. to Joplin Creek flows through urban landscape with considerable habitat alteration.

The candidate reference streams flow through rural watersheds. Candidate reference streams included Trib. to Elm Spring Branch (**TESB**) and MacDougal Branch (**MDB**) in Newton County, Washburn Hollow (**WH**) in Barry County, Motley Branch (**MB**) in Jasper County, and North Fork of the Spring River (**NFS**) Station #11 in Dade County. Prior to the study, reconnaissance was conducted on many stream sites in the Ozark/Neosho EDU that appeared to be appropriate headwater candidate reference stations for this study based on Geographic Information System (**GIS**); however, most of those sites were dry and not suitable for this study.

The Joplin headwater study streams and the candidate reference streams are located within the Ozark/Neosho EDU. See Appendix A for maps of EDUs and the sampling stations for this study. See Table 1 for a comparison of land use for the EDU and the 12-digit Hydrologic Units (**HU**) for the Joplin area headwater sites and the five candidate reference streams.

Table 1
Percent Land Cover

	12-digit HU	Impervious	Urban		Barren/ Sparsely Vegetated	Cropland	Grassland	Forest (Total)	Woody/ Herbaceous (Total)	Wetland (Total)	Open Water
			High Intensity	Low Intensity							
Ozark/Neosho EDU		2.6	0.2	1.9	0.6	15.2	52.8	20.4	4.8	1.1	0.5
All Trib. to Silver Cr. sites	110702070805	5.7	0.2	5.2	0.4	1.7	41.9	36.7	6.1	1.4	0.7
All Trib. to Joplin Cr. sites including its Trib.	110702070901	15.3	1.3	22.1	1.1	2.5	37.9	14.9	3.4	0.9	0.7
Trib. to Elm Spring Br.	110702070802	4.3	1.8	9.5	0.6	2.3	42.5	33.2	5.6	0.1	0.1
MacDougal Br.	110702060201	3.5	0.2	1.4	0.2	3.3	56.5	29.7	4.9	0.1	0.2
WH	110702080101	1.2	0.0	0.6	1.1	2.1	37.6	43.2	14.1	0.0	0.1
Motley Br.	110702070603	1.4	0.0	0.3	0.2	10.2	79.1	5.6	2.4	0.4	0.2
N. Fork Spring #11	110702070201	0.8	0.0	0.2	0.2	49.6	43.6	2.7	1.5	0.7	0.7

2.1 Site Descriptions

As previously mentioned, two study headwater streams were sampled in Joplin and five candidate reference streams were sampled throughout the Ozark/Neosho EDU. Average width, drainage area in square miles (**miles²**), and discharge measurements in cubic feet per second (**cfs**) for each survey period are presented for each station in Table 2. All stations are within the headwater reaches of streams. See Section 3.3 for a description of habitats discussed in this section. See Appendix B for photographic images of sample sites.

These streams were previously unclassified. According to the most recent Chapter 7 of the Missouri Water Quality Standards 10 CSR-7 (MDNR 2014), the streams in this study are now included within the “Missouri Use Designation Dataset Version 1.0” category as of August 20, 2013.

2.1.1 Tributary to Silver Creek

This headwater stream flows through an urbanized landscape but has a variety of habitat regimes. All stations for Trib. to Silver Creek are in Newton County.

Trib. to Silver Creek Station #1 (SE ¼ SE ¼ sec. 24, T. 27 N., R. 33 W) is located just south of I-44 immediately downstream of the concrete drainage ditch carrying the stream. Geographic coordinates at the upstream terminus are UTM Grid 15, East 368315, and North 4100587. This station has natural substrate and banks but no riparian corridor. All three habitats were sampled in the spring season but were of very poor quality, especially rootmat (**RM**). No RM was available for sampling during the fall season.

Trib. to Silver Creek Station #2 (SE ¼ SE ¼ sec. 24, T. 27 N., R. 33 W) is located in the concrete drainage ditch portion of the Trib. to Silver Creek between I-44 and a very small Trib. just a few yards upstream of Station #1. Geographic coordinates at the downstream terminus are UTM Grid 15, East 368326, and North 4100710. This station exhibits the most extreme habitat alteration. Natural bottom substrate and banks have been completely replaced by a concrete channel where the only available cover is benthic algae. There is no riparian corridor present.

Trib. to Silver Creek Station #3 (SE ¼ NW ¼ sec. 19, T. 27 N., R. 32 W) is located behind the Joplin Convention Center just north of I-44. Geographic coordinates at the downstream terminus are UTM Grid 15, East 369197, and North 4101290. This station is located in a uniquely wooded area for its urban setting. It has all natural substrate and adequate riparian corridor. Though RM habitat is present, it is sparse. There was a diesel spill approximately one kilometer upstream of this station in the watershed just prior to the spring sampling season. Upon sampling, a heavy petroleum sheen would rise to the water surface as substrate was disturbed, and a strong diesel odor was present. A response was performed by ESP’s Environmental Emergency Response (**EER**) staff. Refer to EER Incident Report #130329-1730-WMH for further information. During the fall sampling season this station was dry and not sampled.

2.1.2 Tributary to Joplin Creek

This headwater stream flows through an urbanized landscape and is heavily modified. All stations in this system are lacking riparian corridor. Each of the Trib. to Joplin Creek stations and its Trib. are in Jasper County.

Trib. to Joplin Creek Station #1 (SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 2, T. 27 N, R. 33 W) is located at Ewert Park, adjacent to and downstream of the park's public swimming pool. Geographic coordinates at the upstream terminus are UTM Grid 15, East 366471, and North 4105342. The habitat at this site is somewhat modified with a mix of natural and concrete bottom and rough finished concrete banks. The coarse substrate (CS) is primarily loose gravel over bedrock and paved substrate. CS and non-flow were the only two habitats sampled at this station during the spring sample season; however, some RM was found and sampled during the fall season.

Trib. to Joplin Creek Station #2 (NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 11, T. 27 N, R. 33 W) is located off of Murphy Blvd. in front of the old Sears Plaza. Geographic coordinates at the downstream terminus are UTM Grid 15, East 366557, and North 4104945. This station has mixed substrate with mostly natural and some artificial substrate with primarily rough finished concrete banks. There was considerable in-channel and lower bank vegetation at this station. All three habitats were sampled at this station during both seasons.

Trib. to Joplin Creek #3 (NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 12, T. 27 N, R. 33 W) is located in the Joplin Greenway at 12th St. Geographic coordinates at the downstream terminus are UTM Grid 15, East 367530, and North 4104269. This site is completely altered with rough finished concrete bottom and banks. Because the pavement is older, there are minor amounts of cover such as loose pieces of pavement and grassy patches growing through cracks in the pavement. There was only one habitat, concrete substrate (CC), sampled at this station.

Trib. to Joplin Creek #4 (NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 18, T. 27 N, R. 32 W) is located immediately south of the Walgreens on Rangeline. Geographic coordinates at the upstream terminus are UTM Grid 15, East 368731, and North 4103452. The habitat at this station is completely altered with a relatively new, smooth finished concrete channel. The only available cover for macroinvertebrates at this station is benthic algae. CC was the only habitat sampled at this station.

Trib. to Joplin Creek #5 (NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 18, T. 27 N, R. 32 W) is located just south of the Home Depot on Geneva Ave. Geographic coordinates at the downstream terminus are UTM Grid 15, East 368759, and North 4103308. The habitat at this station is similar to Station #4 and was sampled in the same manner.

Trib. to Trib. to Joplin Creek (SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 11, T. 27 N, R. 33 W) is located at the Joplin Greenway between New Hampshire Ave. and Massachusetts Ave. Geographic coordinates at the downstream terminus are UTM Grid 15, East 366927, and North 4104575. This is a very small Trib. with completely rough finished concrete banks and bottom. Like Trib. to Joplin Creek #3, its substrate is older pavement with some grassy

patches growing through the cracks providing very minor amounts of extra cover. The only habitat sampled at this station was CC.

During reconnaissance, a station upstream of Trib. to Joplin Creek #5 was considered at Davis Blvd. This station would have been Trib. to Joplin Creek #6 and sampled downstream of Davis Blvd. However during the day of sampling in the spring season, this station was not a flowing stream, but it instead resembled more of a “wetland” or marshy area (possibly a remediation site) and could not be sampled as a stream.

2.1.3 Candidate Reference Streams

Five candidate reference streams with one station each were selected for comparison with the Joplin modified headwater streams. These candidate reference streams are free from habitat alteration compared to the Joplin streams, and they are all in rural landscapes. Selection for candidate reference streams was consistent with the stepwise process for Selection of Small Candidate Reference Small Streams listed in Appendix E of the Methodology for the Development of the 2016 Selection of 303(d) List in Missouri (see <http://dnr.mo.gov/env/wpp/waterquality/docs/2016-lmd-for-cwc-approval-w-track-changes.pdf>). These streams are considered best available streams in this size class in the Ozark/Neosho EDU that contained flowing water or pools at least during part of the study period. All candidate reference stream stations had good natural substrates, banks, and riparian corridors. Unless otherwise stated, all three riffle/pool habitats were sampled at the candidate reference streams.

Trib. of Elm Spring Branch (NE ¼ sec. 8, T. 24 N, R. 31 W) is located along the south border of MDC’s Crowder Conservation Area upstream of Highway HH east of Neosho in Newton County. Geographic coordinates at the downstream terminus are UTM Grid 15, East 384093, and North 4076593.

MDB (SW ¼ NE ¼ sec. 10, T. 24 N, R. 34 W) is located just upstream of Condor Rd east of Seneca in Newton County. Geographic coordinates at the downstream terminus of this station are UTM Grid 15, East 359246, and North 4077640.

WH (SW ¼ SE ¼ sec. 18, T. 21 N, R. 28 W) is located downstream of the Farm Rd 1050 crossing west of Seligman in Barry County. Geographic coordinates at the upstream terminus are UTM Grid 15, East 410297, and North 4043424. All habitats were sampled in spring. During the fall season, however, much of the streambed was dry and there was no available RM.

MB (SE ¼ NE ¼ sec. 15, T. 27 N, R. 30 W) is located downstream of County Rd 70 west of Sarcxie in Jasper County. Geographic coordinates at the upstream terminus are UTM Grid 15, East 394559, and North 4102064. During the spring sampling season RM was not available. During the fall sampling season this station was completely dry, so it was not sampled at that time. This station was also dry during the week of habitat assessments and instream measurements, so consequentially it was not calculated into the stream habitat portion of the study.

North Fork Spring River #11 (SW ¼ SW ¼ sec. 26, T. 30 N, R. 28 W) is located south-southwest of Lockwood in Dade County just upstream of County Rd 51. Geographic coordinates at the downstream terminus are UTM Grid 15, East 412178, and North 4129379. This station is listed as Station #11 to maintain continuity with previous bioassessment studies conducted in the North Fork Spring River watershed.

Table 2
Physical Characteristics of the Stations

Trib. Silver Creek Station #	Average Width (feet)	Drainage Area (miles ²)	Spring 2013 Flow (cfs)	Fall 2013 Flow (cfs)
1	18.5	2.46	0.8	<0.1
2	11.0	2.46	0.9	<0.1
3	18.5	1.37	0.7	*
Trib. Joplin Creek Station #				
1	40.0	3.1	1.3	0.3
2	30.0	3.1	0.9	0.4
3	22.5	2.15	0.5	0.1
4	18.0	0.6	0.1	<0.1
5	17.5	0.6	<0.1	<0.1
Trib.	16.0	2.2	0.1	0.1
Candidate Reference Streams				
Trib. To Elm Sp. Br.	11.5	2.23	1.7	0.1
MacDougal Br.	20.0	5.89	7.1	1.5
WH	26.5	4.77	0.8	0.1**
Motley Br.	*	7.41	2.0	*
North Fk. Spring R. #11	30.0	6.33	3.4	0.4

*Site was dry.

**Flow measured at active run. Sampled segment was isolated between dry zones.

3.0 Methods

Spring sampling was conducted at the five candidate reference stations on April 2nd and 3rd, 2013, by Carl Wakefield, Brandy Bergthold, and Ken Lister. The Joplin headwater study streams were sampled on April 9, 2013, by Brian Nodine, Brandy Bergthold, and Randy Sarver. Fall sampling was conducted on the Joplin headwater study streams on September 24th and on the candidate reference streams on September 25, 2013, by Brian Nodine, Dave Michaelson, Ken Lister, and Randy Sarver. During June 16th through 19th, 2014, habitat assessments and instream measurements were conducted by Brian Nodine and Dave Michaelson. Photographs of sample stations were taken by Dave Michaelson during this trip as well.

For quality control purposes, duplicate macroinvertebrate samples (**DUP**) were collected at MacDougal Branch during the fall sampling season. For duplicate macroinvertebrate samples, both samplers collected samples adjacent to each other for each net set in each habitat. Those duplicate results are reported as Stations #1A and #1B in the macroinvertebrate bench sheets in Appendix C. Duplicate water quality samples were also collected with this sample as well as the Trib. to Joplin Creek #1 station during the spring season and the Trib. to Joplin Creek #2 station during the fall season. Typically macroinvertebrate and water quality duplicates are collected together; however, limited habitat restricted the ability to collect DUP in most of these headwater streams.

3.1 Habitat

Stream modification for urban storm water drainage can be associated with instream habitat problems. These problems result in hydrologic changes and channelization as well as loss of instream epifaunal substrate cover, bank vegetation, riparian vegetation, and depth and flow heterogeneity. This study looked at changes in habitat between stream stations modified for storm water drainage and those without such modification. Stream stations within the city limits of Joplin were chosen that exhibited varying degrees of habitat alteration as well as rural candidate reference streams with no instream habitat modification.

3.1.1 Land Use

Land cover data were derived from the Thematic Mapper satellite data from 2001-2004 and interpreted by the Missouri Resource Assessment Partnership (**MoRAP**). See Table 1 in Section 2.0 for land use information.

3.1.2 Habitat Assessment

A standardized habitat procedure for riffle/pool stream types was followed per the *Stream Habitat Assessment Project Procedure* (**SHAPP**) (MDNR 2010a).

3.1.3 Instream Width and Depth Measurements

Typically streams modified for urban storm water management tend to have shallower and more homogeneous depths and a lack of instream habitat. At each station a series of 10 bank-to-bank transects were established within a stream segment equal to 20 times the average width (as described in the SHAPP). Each individual transect was then established two average widths apart. A series of 11 cross-section measurements were taken at each station to bracket the 10 transects. At each cross section, channel width, wetted width, and nine evenly spaced depth measurements were taken. These assessments and measurements were attempted during the fall sampling season; however, Trib. to Silver Creek #3 was dry, so these procedures were postponed until there was enough water to conduct them in all study stations. MB remained dry so it was not included in the habitat assessment and instream measurement process.

3.2 Physicochemical Data Collection and Analysis

During each survey period, *in situ* water quality measurements were collected at all stations for temperature (°C), dissolved oxygen concentration (mg/L), conductivity (µS/cm), and pH. These measurements followed Standard Operating Procedures MDNR-ESP-101 *Field Measurement of Water Temperature* (MDNR 2010b), MDNR-ESP-103 *Sample Collection and Field Analysis for Dissolved Oxygen Using a YSI Membrane Electrode Meter, Hach HQ40d LDO Probe or YSI Pro ODO Probe* (MDNR 2012a), MDNR-ESP-102 *Field Analysis for Specific Conductance* (MDNR 2010c), and MDNR-ESP-100 *Field Analysis of Water Samples for pH* (MDNR 2012b), respectively. Additionally, water samples were collected and analyzed by ESP's Chemical Analysis Section (CAS) for chloride, sulfate, total phosphorus, ammonia-N, nitrate + nitrite-N, total nitrogen, non-filterable residue (NFR), total recoverable magnesium (TR-Mg), total recoverable calcium (TR-Ca), and hardness. Turbidity in Nephelometric Turbidity Units (NTU) was analyzed by the WQMS.

Stream discharge in cfs was measured at each sampling station using a Marsh-McBirney Flo-Mate™ Model 2000. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-ESP-113 *Flow Measurement in Open Channels* (MDNR 2013).

Physicochemical data were summarized and presented in tabular form for comparison among the Joplin modified headwater streams and the candidate reference headwater streams for both seasons.

3.3 Biological Analysis

3.3.1 Macroinvertebrate Collection and Analysis

Because the study stream stations were smaller and classified differently than wadeable/perennial stations and one goal of this study is to gain experience developing headwater references, five candidate reference stations within the same EDU were chosen to use as comparisons rather than standard wadeable/perennial stations.

A standardized sample collection procedure was followed as described in the *Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)* (MDNR 2012c). Three standard habitats for riffle/pool streams were sampled at all feasible locations. These habitats included CS, non-flowing water with depositional substrate (NF), and RM at the stream edge. At highly modified streams where only paved bottoms and banks were available, CC was sampled. CC habitat was sampled by brushing debris from the bottom of the waterway into a 500 µm Nitex® mesh bag typically used for collecting samples from woody debris habitat as described in the SMSBPP. See Table 3 for the habitats sampled for each station during each season.

Table 3
Habitats Sampled Per Station for Each Season

	Trib. Silver Cr.			Trib. of Joplin Cr. Station						Candidate Reference					
	1	2	3	1	2	3	4	5	Trib	TESB	MDB	MDB (DUP)	WH	MB	NFS
Spring 2013															
CS	X		X	X	X					X	X	X	X	X	X
Non-Flow	X		X	X	X					X	X	X	X	X	X
RM	X		X		X					X	X	X	X		X
CC		X				X	X	X	X						
Fall 2013															
CS	X		*	X	X					X	X	X	X	*	X
Non-Flow	X		*	X	X					X	X	X	X	*	X
RM			*	X	X					X	X	X		*	X
CC		X	*			X	X	X	X					*	

*Dry and not sampled

A standardized sample analysis procedure was followed as described in the SMSBPP for multi-metric scoring and support rankings for the test stations. The SMSBPP provides details on the calculation of metrics and scoring. The following four metrics were used: 1) Taxa Richness (**TR**); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**).

Macroinvertebrate data were analyzed in specific ways. First, study stream stations were compared to draft criteria for the candidate reference stations in the Ozark/Neosho EDU. Second, a longitudinal comparison between the study stream sites was performed. Finally, a comparison was made of study stream data between fall and spring sampling seasons.

3.3.2 Fish Collection and Analysis

Fish were collected by MDC staff in accordance with fish sampling protocols specified in MDC Standard Operating Procedures (MDC 2011).

4.0 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in pertinent Standard Operating and Project Procedures.

5.0 Data Results and Analyses

5.1 Habitat

5.1.1 Land Use

See Table 1 in Section 2.0 for MoRAP land cover results.

5.1.2 Habitat Assessment

Habitat assessment scores were recorded for each sampling station (with the exception of MB). Results are presented in Table 4. According to project procedure guidance, the total score from the physical habitat assessment of the study sites should be at least 75% of the control station score (or mean score of multiple control sites) to support a similar biological community. Habitat scores for the study stations were compared with the mean of habitat scores from the four available candidate reference streams. Only Trib. to Silver Creek Stations #1 and #3 attained the 75% threshold. These were the only two study stations that did not have channels modified with concrete.

Of the Trib. to Joplin Creek sites, Station #2 scored relatively better than the remaining study stations with a habitat score that was 71% of the mean of the candidate reference streams. Trib. to Joplin Creek #2 was the only station to reach a fully supporting ranking during this study (see Section 5.3.1.2) in spite of not attaining the 75% threshold habitat score. This is likely due to individual habitat assessment parameters, such as epifaunal substrate, that tend to more directly support macroinvertebrate colonization. As previously mentioned, this station was only partially modified with paved banks with mostly natural substrate. This provided adequate epifaunal substrate and an adequate degree of depth and flow heterogeneity for macroinvertebrate habitat. Most of the other study stations received scores that fell well below the 75% threshold.

Table 4
Stream Habitat Assessment Scores (June 2014)

Candidate Reference Stream	Habitat Score	Study Station	Habitat Score	Percent of Mean Candidate Reference Score
MacDougal Br.	166	Trib. to Silver #1	120	84
Trib. to Elm Spring Br.	140	Trib. to Silver #2*	53†	37†
WH	130	Trib. to Silver #3	137	96
N. Fork Spring #11	135	Trib. to Joplin #1**	85†	59†
		Trib. to Joplin #2**	102†	71†
Mean Candidate Reference Score	143	Trib. to Trib. Joplin*	49†	34†
		Trib. to Joplin #3*	50†	35†
75% of Mean Candidate Ref. Score	107	Trib. to Joplin #4*	56†	39†
		Trib. to Joplin #5*	49†	34†

*Paved substrate and banks

** Paved banks with natural substrate

†Failed to attain 75% threshold

5.1.3 Instream Measurements

See Table 5 for instream measurement results. Instream measurements were compared between stations with predominantly natural versus concrete-only substrates. These comparisons provided insight into habitat conditions related to water depth regimes.

Stations with concrete-only substrates tended toward lower average depths, lower maximum depths, lower depth heterogeneity, and higher wetted width to depth ratio, all of which resulted in restricted conditions for biological communities.

Table 5
Channel Measurements

Station	Substrate	Banks	Avg. Channel Width (ft.)	Avg. Wetted Width (ft.)	Avg. Depth (ft.)	Max. Depth (ft.)	Standard Deviation of Depth	Channel Width: Wetted Width	Wetted Width: Avg. Depth
Trib. Silver #1	natural	natural**	18.45	12.68	0.44	1.8	0.25	1.46	28.82
Trib. Silver #2	paved	paved	11.00	7.14	0.11	0.2	0.06	1.54	64.91
Trib. Silver #3	natural	natural	18.50	8.14	0.35	1.7	0.38	2.27	23.26
Trib. Joplin #1	natural*	paved	40.09	17.59	0.98	2.6	0.67	2.28	17.95
Trib. Joplin #2	natural	paved	30.91	12.05	0.67	2.2	0.49	2.57	17.99
Trib. Trib. Joplin	paved	paved	15.91	3.82	0.20	0.4	0.09	4.16	19.1
Trib. Joplin #3	paved	paved	22.64	6.73	0.20	0.5	0.11	3.36	33.65
Trib. Joplin #4	paved	paved	17.91	14.55	0.11	0.2	0.06	1.23	132.27
Trib. Joplin #5	paved	paved	17.50	7.91	0.09	0.2	0.03	2.21	87.89
MacDougal Br.	natural	natural	20.05	17.77	0.67	1.9	0.45	1.13	26.52
Trib. Elm Spring	natural	natural	11.45	6.41	0.26	1.0	0.22	1.79	24.65
WH	natural	natural	26.73	13.27	0.30	0.7	0.19	2.01	44.23
N. Fork Spring #11	natural	natural	29.82	19.17	0.68	1.8	0.40	1.56	28.19

*Natural substrate, mostly bedrock with some paved bottom

**Natural banks with all riparian removed

The following figures present channel morphology graphically. All comparisons are between predominantly natural and concrete-only substrate.

Figure 1
Average Depth Comparisons between Natural and CCs

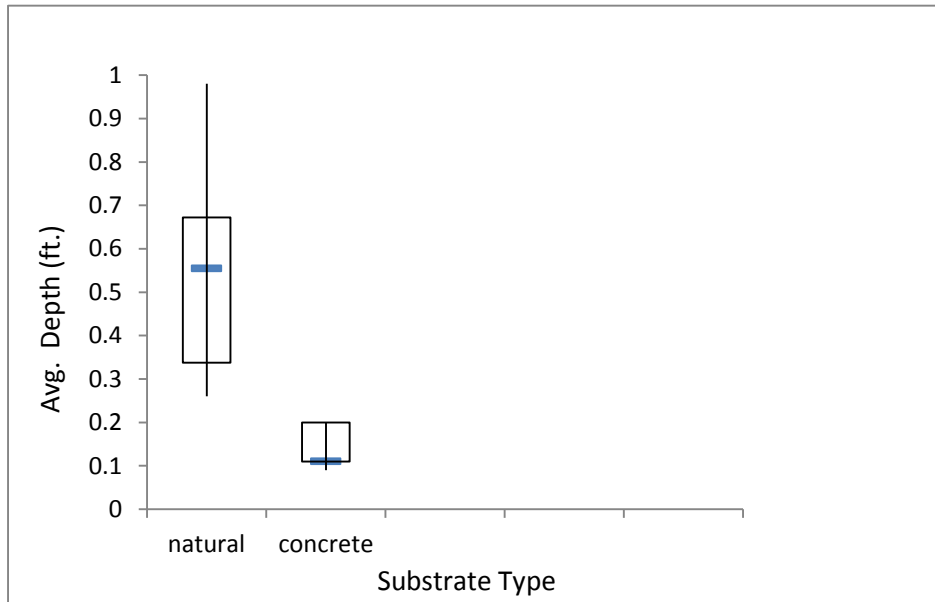


Figure 2
Maximum Depth Comparisons between Natural and CCs

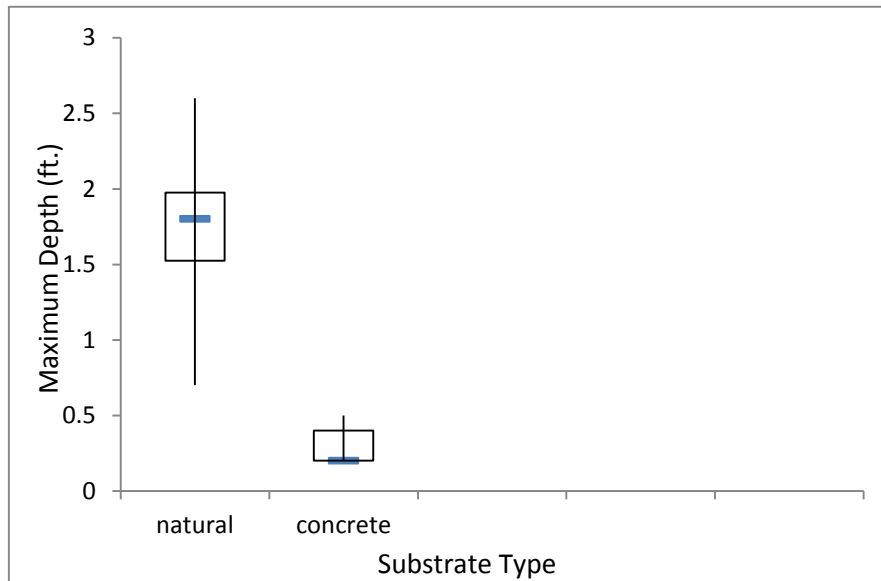


Figure 3 represents the comparisons of wetted width to average depth ratios. A higher ratio indicates a tendency toward a wider and shallower wetted channel.

Figure 3
Wetted Width to Average Depth Ratio Comparisons between Natural and CCs

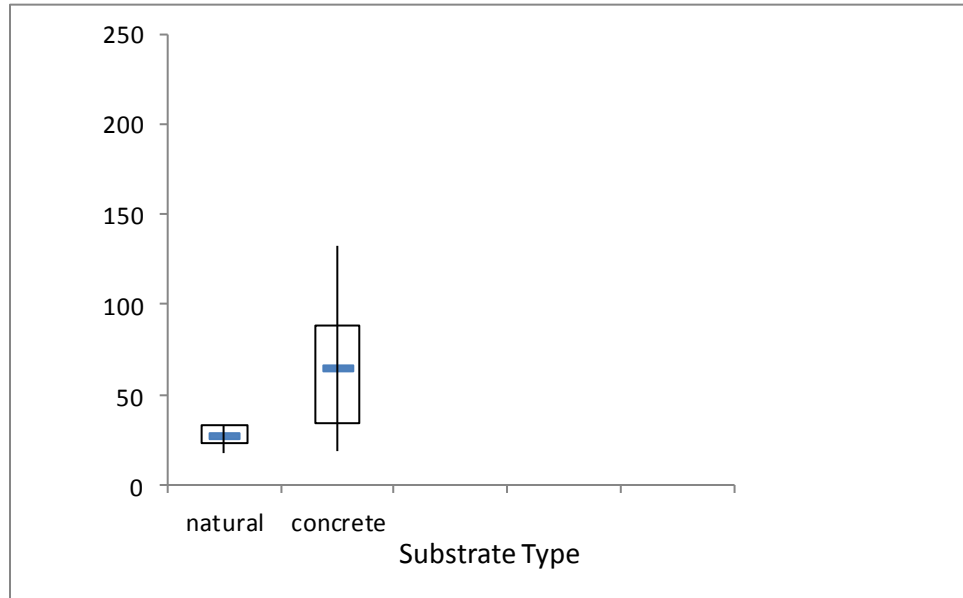
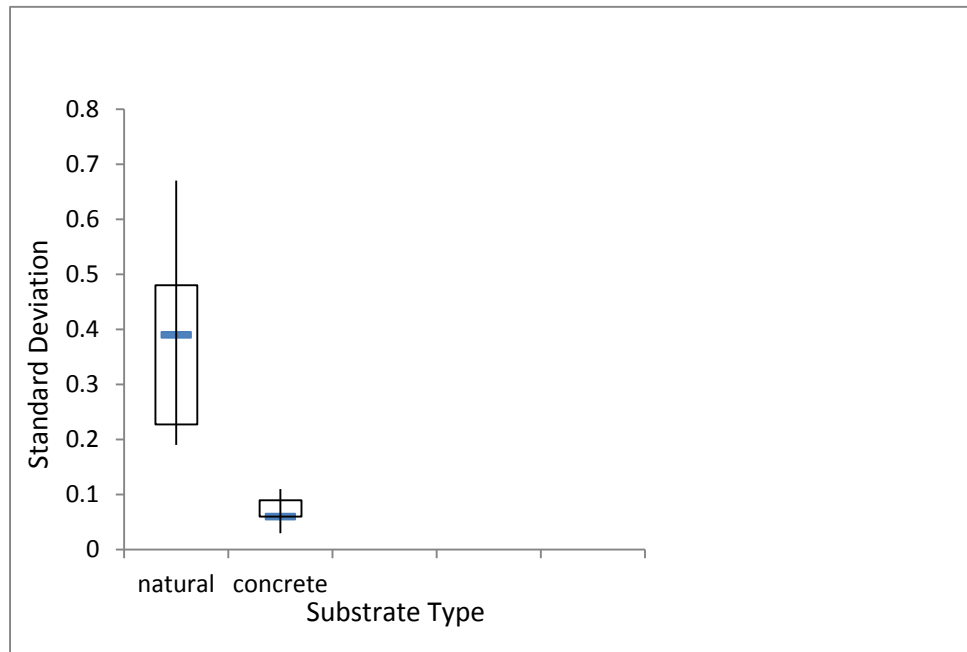


Figure 4 represents the comparisons of the standard deviations of depth measurements. A higher standard deviation within a given sample station represents a greater heterogeneity of depth regimes while a lower standard deviation indicates more homogeneous (typically shallower) depth regimes.

Figure 4
Standard Deviation of Depth Comparison between Natural and CCs



5.2 Physicochemical Data

In situ water quality measurements and turbidity are summarized in Table 6 (spring 2013) and Table 7 (fall 2013). Water temperatures were somewhat consistent within stream systems within seasons and were predictably lower during the spring (late winter) than fall (late summer) season.

Conductivity levels tended to be higher in the urban study streams. In the study streams, conductivity levels ranged from 480-880 $\mu\text{S}/\text{cm}$ during the spring season and 381-622 $\mu\text{S}/\text{cm}$ during the fall season. By contrast the candidate reference streams' conductivity levels ranged from 150-355 $\mu\text{S}/\text{cm}$ during the spring season and 243-405 $\mu\text{S}/\text{cm}$ during the fall season.

Dissolved oxygen levels were typically well above the Water Quality Standards (MDNR 2014) minimum concentration for warm-water and cool-water fisheries (5.0 mg/L). The only sample that came close to the minimum allowable concentration was WH during the fall season, which was likely due to much of the streambed being dry.

Table 6
In situ Water Quality Measurements and Turbidity at all Stations (Spring 2013)

Station	Parameter				
	Temp. (°C)	Dissolved O ₂ (mg/L)	Spec. Cond. (µS/cm)	pH	Turbidity (NTU)
Trib. Silver #1	18.4	11.90	590	8.6	2.71
Trib. Silver #2	18.3	12.60	590	8.7	1.44
Trib. Silver #3	16.9	7.70	630	7.5	3.24
Trib. Joplin #1	20.3	11.90	640	8.3	1.11
Trib. Joplin #1 (DUP)	20.2	12.00	640	8.3	1.42
Trib. Joplin #2	21.5	10.65	670	8.3	1.99
Trib. Joplin #3	20.4	9.64	480	8.2	2.39
Trib. Joplin #4	22.3	12.20	780	8.6	2.94
Trib. Joplin #5	20.8	12.35	540	8.4	2.84
Trib. to Trib. Joplin	19.6	8.59	880	7.7	2.55
Trib. to Elm Sp. Br.	11.0	10.92	150	8.5	3.61
MacDougal Br.	13.0	10.11	238	8.0	4.10
WH	8.0	12.65	355	8.8	4.60
Motley Br.	8.0	13.59	179	8.5	5.84
North Fk. Spring #11	9.0	13.81	240	8.4	7.71

Table 7
In situ Water Quality Measurements and Turbidity at all Stations (Fall 2013)

Station	Parameter				
	Temp. (°C)	Dissolved O ₂ (mg/L)	Spec. Cond. (µS/cm)	pH	Turbidity (NTU)
Trib. Silver #1	23.0	11.70	468	8.6	3.14
Trib. Silver #2	23.0	11.38	483	8.7	3.12
Trib. Silver #3*					
Trib. Joplin #1	23.0	12.52	510	8.4	1.82
Trib. Joplin #2	22.0	9.86	584	8.2	3.31
Trib. Joplin #2 (DUP)	22.0	9.85	584	8.2	3.05
Trib. Joplin #3	25.0	10.76	397	8.1	5.26
Trib. Joplin #4	24.0	10.43	424	8.4	13.0
Trib. Joplin #5	25.0	13.29	381	8.6	6.72
Trib. to Trib. Joplin	23.0	8.98	622	8.1	2.71
Trib. to Elm Sp. Br.	15.0	8.71	243	8.1	2.40
MacDougal Br.	15.0	8.86	292	7.9	2.06
MacDougal Br. (DUP)	15.0	8.91	292	7.9	2.08
WH	18.0	5.29	405	7.8	1.20
Motley Br.*					
North Fk. Spring #11	18.0	8.61	274	8.2	1.97

* Dry and not sampled

Water chemistry concentrations for all stations are presented in Table 8 (spring 2013) and Table 9 (fall 2013). No water chemistry results exceed Water Quality Standards (MDNR 2014).

Table 8
Water Chemistry Concentrations at all Stations (Spring 2013)

Station	Sample #	Parameter (mg/L)									
		NH ₃ -N	NO ₃ +NO ₂ -N	T-N	T-P	Hardness	TR-Ca	TR-Mg	Chloride	Sulfate	NFR
Trib. Silver #1	132382	0.10	0.38	0.71	0.018	156	56.8	3.55	88.8	24.4	14.0
Trib. Silver #2	132383	0.084	0.32	0.58	0.013	148	54.0	3.30	92.8	24.4	5.00
Trib. Silver #3	132384	0.076	0.14	0.44	0.019	150	54.7	3.26	101	23.5	8.00
Trib. Joplin #1	132385	0.086	0.63	0.86	<0.01	281	102	6.37	21.8	118	<5
Trib. Joplin #1 (DUP)	132386	0.087	0.63	0.81	<0.01	278	101	6.31	21.3	119	<5
Trib. Joplin #2	132387	0.067	0.68	0.87	<0.01	293	107	6.26	21.2	117	<5
Trib. Joplin #3	132389	0.11	0.74	1.03	0.012	193	68.2	5.44	22.4	53.7	<5
Trib. Joplin #4	132390	0.090	0.01	0.28	0.012	197	67.7	6.87	21.6	56.9	<5
Trib. Joplin #5	132391	0.058	0.02	0.14	<0.01	257	93.3	5.83	18.6	56.1	<5
Trib. Trib. Joplin	132388	0.080	0.65	0.84	0.016	398	148	6.84	17.5	234	<5
Trib. Elm Sp.	131720	0.049	1.46	1.57	0.015	64.8	24.2	1.05	3.53	5.55	<5
MacDougal Br	131719	<0.03	2.67	2.85	0.025	101	38.3	1.27	8.81	5.56	<5
Washburn H.	131714	<0.03	4.00	4.37	0.014	171	65.5	1.75	6.99	8.73	<5
Motley Br.	131721	0.088	2.06	2.51	0.037	69.0	23.5	2.51	8.14	7.89	<5
N. Fk. Spring	131722	0.092	2.56	3.17	0.060	101	34.8	3.54	14.1	9.39	<5

Table 9
Water Chemistry Concentrations at all Stations (Fall 2013)

Station	Sample #	Parameter (mg/L)									
		NH ₃ -N	NO ₃ +NO ₂ -N	T-N	T-P	Hardness	TR-Ca	TR-Mg	Chloride	Sulfate	NFR
Trib. Silver #1	133939	0.13	0.36	0.66	<0.01	168	60.3	4.33	79.4	21.9	<5
Trib. Silver #2	133941	0.061	0.37	0.64	<0.01	162	57.9	4.26	83.7	21.2	<5
Trib. Silver #3*											
Trib. Joplin #1	133942	0.033	0.12	0.36	<0.01	296	108	6.51	18.5	132	<5
Trib. Joplin #2	133943	0.065	0.30	0.72	0.044	368	136	7.00	18.6	150	52.0
Trib. Joplin #2 (DUP)	133944	0.051	0.29	0.68	0.038	353	130	6.87	17.9	148	50.0
Trib. Joplin #3	133946	0.033	0.30	0.56	<0.01	213	75.6	5.91	19.9	48.9	6.00
Trib. Joplin #4	133947	0.063	0.085	0.43	<0.01	230	81.0	6.81	23.2	57.1	19.0
Trib. Joplin #5	133948	0.10	<0.008	0.82	0.021	174	59.5	6.24	17.4	76.7	24.0
Trib. Trib. Joplin	133945	0.034	0.38	0.59	<0.01	381	142	65.1	19.7	166	<5
Trib. Elm Sp.	133949	<0.03	0.97	0.99	<0.01	143	54.9	1.41	6.14	6.70	<5
MacDougal Br	133950	<0.03	2.48	2.54	<0.01	170	65.2	1.82	9.08	6.19	<5
MacDougal Br (DUP)	133951	<0.03	2.49	2.53	<0.01	168	64.3	1.79	9.16	6.09	<5
Washburn H.	133952	<0.03	1.92	2.13	<0.01	254	98.0	2.32	7.43	9.43	<5
Motley Br.*											
N. Fk. Spring	133953	0.036	3.90	4.44	0.032	145	51.2	4.09	15.0	11.5	<5

* Dry and not sampled

5.3 Biological Assessment

5.3.1 Macroinvertebrate Data

5.3.1.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)

The SMSBPP evaluation used biological criteria that were calculated from the candidate reference streams in the Ozark/Neosho EDU. See the SMSBPP (MDNR 2012c) for more explanation on criteria calculation. These criteria are listed for spring and fall seasons in Tables 10 and 11, respectively. Multi-metric scores of 20-16 qualify as fully supporting, 14-10 as partially supporting, and 8-4 as non-supporting of the “protection of aquatic life” beneficial use designation as specified in Missouri’s Water Quality Standards (MDNR 2014).

Table 10
Biological Criteria for Candidate Reference Streams for Joplin Modified Headwater Stream Study in the Ozark/Neosho EDU (Spring 2013 Season)

Metric	Score = 5	Score = 3	Score =1
TR	>36	18-36	<18
EPTT	>5	3-5	<3
BI	<6.5	8.3-6.5	>8.3
SDI	>2.26	1.13-2.26	<1.13

Table 11
Biological Criteria for Candidate Reference Streams for Joplin Modified Headwater Stream Study in the Ozark/Neosho EDU (Fall 2013 Season)

Metric	Score = 5	Score = 3	Score =1
TR	>65	33-65	<33
EPTT	>10	5-10	<5
BI	<6.9	6.9-8.5	>8.5
SDI	>3.2	1.6-3.2	<1.6

For strictly comparative purposes, see Tables 12 and 13 for Biological Criteria for Ozark/Neosho EDU Wadeable/Perennial Streams of Missouri for spring and fall 2013, respectively.

Table 12
Biological Criteria for Warm Water Reference Streams in the Ozark/Neosho EDU (Spring Season)

Metric	Score = 5	Score = 3	Score =1
TR	>72	36-72	<36
EPTT	>27	13-27	<13
BI	<5.3	5.3-7.7	>7.7
SDI	>3.01	1.51-3.01	<1.51

Table 13
Biological Criteria for Warm Water Reference Streams in the Ozark/Neosho EDU (Fall Season)

Metric	Score = 5	Score = 3	Score = 1
TR	>77	39-77	<39
EPTT	>24	12-24	<12
BI	<5.5	5.5-7.7	>7.7
SDI	>2.97	2.97-1.49	<1.49

5.3.1.2 Comparisons with Candidate Reference Streams in the Ozark/Neosho EDU

Multi-metric scores were calculated based on biological criteria from Ozark/Neosho EDU candidate reference streams. The four metrics, total multi-metric scores, and support rankings during spring 2013 and fall 2013 are presented in Tables 14 and 15, respectively.

Table 14
Metric Values (and Scores), Multi-metric Scores, and Support Rankings Based on Candidate Reference Stream Criteria for the Joplin Area Modified Headwater Study (Spring 2013)

Station	Sample #	TR	EPTT	BI	SDI	M-M Score	Support Category
Trib. Silver #1	131922	34(3)	2(1)	7.3(3)	2.15(3)	10	Partially
Trib. Silver #2*	131923	11(1)	0(1)	5.6(5)	0.86(1)	8	Non
Trib. Silver #3	131924	24(3)	2(1)	7.2(3)	2.25(3)	10	Partially
Trib. Joplin #1	131925	30(3)	3(3)	6.6(3)	2.07(3)	12	Partially
Trib. Joplin #2	131926	47(5)	8(5)	7.1(3)	1.96(3)	16	Fully
Trib. Joplin #3*	131928	24(3)	3(3)	6.4(5)	1.62(3)	14	Partially
Trib. Joplin #4*	131929	16(1)	1(1)	5.5(5)	1.42(3)	10	Partially
Trib. Joplin #5*	131930	5(1)	0(1)	5.5(5)	0.87(1)	8	Non
Trib. to Trib. Joplin*	131927	21(3)	3(3)	6.5(3)	1.09(1)	10	Partially

* Concrete-only substrate

Table 15
Metric Values (and Scores), Multi-metric Scores, and Support Rankings Based on
Candidate Reference Stream Criteria for the Joplin Area Modified Headwater Study
(Fall 2013)

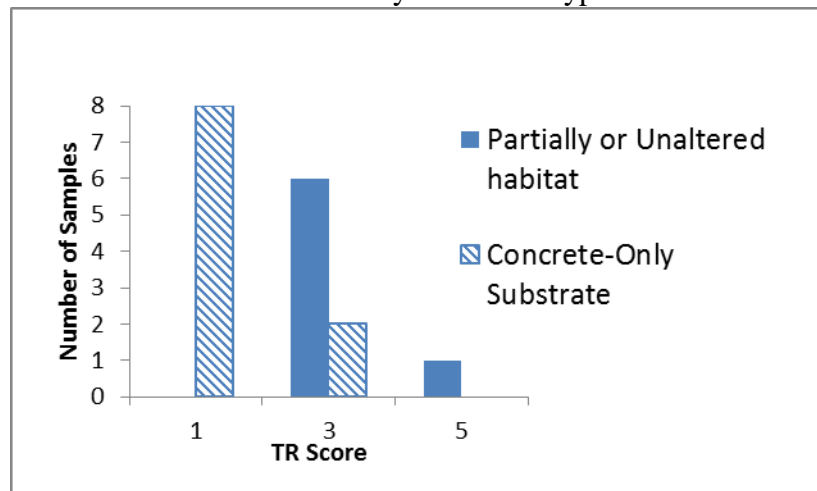
Station	Sample #	TR	EPTT	BI	SDI	M-M Score	Support Category
Trib. Silver #1	132007	50(3)	8(3)	7.1(3)	2.96(3)	12	Partially
Trib. Silver #2*	132008	19(1)	2(1)	5.7(5)	1.73(3)	10	Partially
Trib. Joplin #1	132009	50(3)	9(3)	7.7(3)	2.53(3)	12	Partially
Trib. Joplin #2	132010	51(3)	8(3)	7.7(3)	1.89(3)	12	Partially
Trib. Joplin #3*	132012	19(1)	4(1)	7.0(3)	2.11(3)	8	Non
Trib. Joplin #4*	132013	20(1)	3(1)	6.1(5)	2.08(3)	10	Partially
Trib. Joplin #5*	132014	14(1)	2(1)	7.1(3)	1.5(1)	6	Non
Trib. to Trib. Joplin*	132011	22(1)	5(3)	6.7(5)	1.92(3)	12	Partially

* Concrete-only substrate

With the exception of Trib. to Joplin Creek #2 during the spring sampling season, all study stations failed to receive a “fully” supporting ranking when compared with criteria from the candidate reference streams. The fully supporting ranking at this particular station is likely due to more available habitat (see Section 2.1.2) than most of the other study stations. The stations with concrete-only substrate were the only stations to receive non-supporting rankings.

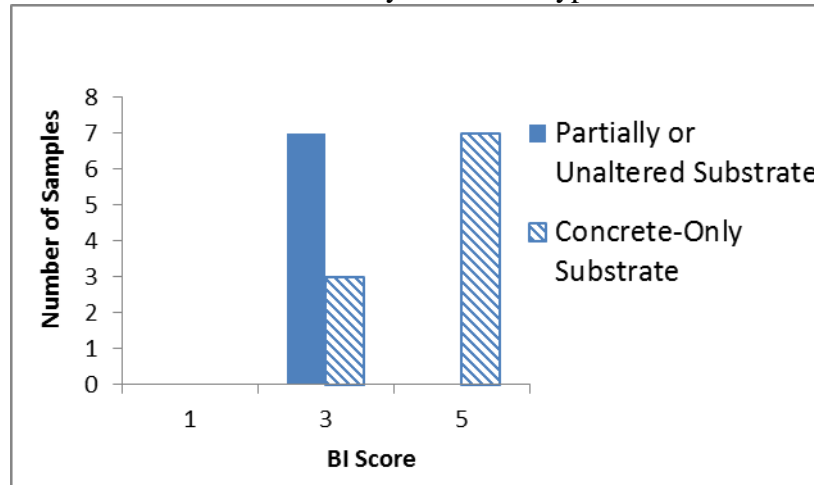
A pattern appeared between individual metrics and concrete-only substrate. Of all the study samples, only stations with concrete-only substrate received a TR score of “1.” Specifically, eight of the 10 samples from concrete-only substrate received a TR score of “1,” and the other two received scores of “3” (see Figure 5). To a lesser degree, EPTT scores also tended to be lower in concrete-only substrate samples.

Figure 5
TR Scores by Substrate Type



BI scores tended to be higher in concrete-only substrate stations compared to streams with partially-altered or unaltered substrate. Of the 10 total samples from concrete-only substrate stations, seven had BI scores of “5.” The only samples receiving this highest possible BI score in this study were from concrete-only substrate stations (See Figure 6).

Figure 6
BI Scores by Substrate Type



Strictly for the sake of comparison, study stream data were scored using wadeable/perennial biological criteria from the Ozark/Neosho EDU (see Tables 12 and 13). Scores dropped to non-supporting for all samples except the spring Trib. to Joplin Creek #2 sample and fall samples collected from Trib. to Silver Creek #1 and Trib. to Joplin Creek Stations #1 and #2. The number of non-supporting scores increased from four to 13 samples when using wadeable/perennial criteria rather than candidate reference criteria. The wadeable/perennial criteria scoring thresholds for TR and EPTT were higher than the candidate reference thresholds. These biological metrics were the main contributors to the difference in support rankings in the overall scores. The scores for BI and SDI rarely changed when compared with wadeable/perennial streams.

5.3.1.3 Tributary to Silver Creek Longitudinal Comparisons

Macroinvertebrate samples from stations at Trib. to Silver Creek that retain natural substrate received partially supporting rankings during both seasons. Station #2, the station that was completely altered by CC and banks, received a non-supporting ranking during spring season and a partially supporting ranking during the fall season.

5.3.1.4 Tributary to Joplin Creek Longitudinal Comparisons

The only study station to receive a fully supporting ranking was Station #2 during the spring season. During both seasons Station #5 received a non-supporting ranking as did Station #3 during the fall season. All other samples received partially supporting rankings.

5.3.1.5 Seasonal Comparisons

The most notable differences between seasons were at Trib. to Joplin Creek Stations #2 and #3. Multi-metric scores dropped from 16 to 12 at Station #2 and from 14 to 8 at Station #3 between the spring and fall sampling seasons. One likely cause of this drop in scores is the reduction in flow that occurred between seasons that resulted in two stations, one study station and one candidate reference, being dry and unavailable for sampling.

5.3.1.6 Macroinvertebrate Percent and Community Composition

Percent composition and relative abundance of Diptera and EPT as well as the top five dominant families are presented in Table 16 for the spring sampling season and Table 17 for the fall sampling season. The percent of relative abundance data were averaged from the sum of all habitats sampled at each station. See Appendix C for bench sheets for all macroinvertebrate samples.

Diptera was frequently the dominant order, especially in study stations with concrete-only substrate. Among these samples, Chironomidae was the dominant family. Stations with concrete-only substrate also had a notably low, or absent, representation of EPTT, particularly during the spring sampling season.

Overall, concrete-only stations demonstrated some notable differences in macroinvertebrate community composition compared to candidate reference streams, especially the spring season (Tables 16 and 17). For example, during the spring season the family Chironomidae made up over 99 percent of the Trib. to Silver Creek #2 sample, and only two other families were present to make up the remaining <1 percent. No EPTT were present at this site. Trib. to Joplin Creek #5 also had only three families represented during the spring season. During that season, even concrete-only stations having at least five families were dominated by Chironomidae. Other families tended to be poorly represented, with the notable exceptions of Planariidae and Tubificidae. Another noticeable trend in concrete-only substrate stations during the spring season is the near absence of EPTT. By contrast the candidate reference streams generally had higher EPTT abundance and lower Diptera percentages.

The fall season does not show quite the stark differences in community composition in this format as the spring season. However Chironomidae still, to a notable degree, outweighs EPTT in the concrete-only stations more so than the candidate reference streams.

The SMSBPP requires DUP be collected for quality control purposes. The Quantitative Similarity Index for Taxa (**QSI-T**) is used to compare taxa similarity between DUP. According to the SMSBPP, duplicate samples are expected to have a similarity of at least 70% (MDNR 2012c). The QSI-T for the two duplicates collected at MDB station during the fall season met this criterion with a QSI-T = 77%.

Table 16
Spring 2013 Macroinvertebrate Composition (percentages rounded to whole numbers)

	Trib. Silver Cr.			Trib. of Joplin Cr. Station						Candidate Reference				
	1	2*	3	1	2	3*	4*	5*	Trib*	TESB	MDB	WH	MB	NFS
% Ephemeroptera	1	0	9	2	14	3	0	0	<1	11	28	6	1	4
% Plecoptera	0	0	0	0	0	0	0	0	0	9	5	25	15	0
% Trichoptera	0	0	0	0	<1	0	1	0	<1	5	4	<1	0	3
Total % EPT	1	0	9	2	14	3	1	0	<1	25	37	32	16	7
% Diptera	27	>99	9	69	53	89	76	63	98	50	16	12	42	79
% Top Five Dominant Families														
Chironomidae	26	>99		68		89	76	63	98	46	16	12	33	78
Gammaridae										8				
Leuctridae										6	16		14	
Baetidae									<1	6	14			
Elmidae	12		36	11	4				1	4				8
Heptageniidae			9								9			
Asellidae											9	54	1	
Perlodidae												12		
Nemouridae												10		
Siphonuridae												4		
Enchytraeidae			11				1						39	
Simuliidae													5	
Caenidae				2	12	3								4
Planariidae	3	<1	9	6	7		17	36	<1					3
Tubificidae	11		10	8		2	5	1						2
Physidae	13	<1			14									
Hydrophilidae						2								
Coenagrionidae						2								
Hydroptilidae							1							
Hydropsychidae									<1					

* Concrete-only substrate.

Shaded cells indicate that the family was not among the top five dominant families for that site.
See Section 5.3.1.6 for the explanation of stations with fewer than five families.

Table 17
Fall 2013 Macroinvertebrate Composition (percentages rounded to whole numbers)

	Trib. Silver Cr.			Trib. of Joplin Cr. Station						Candidate Reference				
	1	2*	3	1	2	3*	4*	5*	Trib*	TESB	MDB	MDB (DUP)	WH	NFS
% Ephemeroptera	22	30		37	64	57	6	2	24	10	30	28	13	3
% Plecoptera	0	0		0	0	0	0	0	0	6	3	3	1	0
% Trichoptera	13	3		16	2	<1	<1	<1	2	9	19	14	<1	7
Total % EPT	35	33		53	66	57	6	2	26	25	52	45	14	10
% Diptera	37	51		16	10	32	82	91	68	25	16	13	4	58
% Top Five Dominant Families														
Chironomidae	36	51		15	10	32	82	91	66	22	14	10	4	57
Baetidae	16	30		8	3	24	6	8	20		24	21	3	
Elmidae	13													7
Tubificidae	9					3	3							10
Coenagrionidae	7			27	9			1						
Planariidae		13					3	5						
Hydroptilidae		3						<1						
Caenidae				27	60	32			3					
Physidae				11	8		3	<1						
Hydrophilidae		1				7								
Pisidiidae									2					
Veliidae									2					
Gammaridae										22				
Elmidae										8		11		
Perlidae										6				
Leptophlebiidae										5				
Hydropsychidae											14	12		6
Asellidae											8	8	80	
Psephenidae											7			
Heptageniidae													10	
Dytiscidae													1	
Ancylidae														3

* Concrete-only substrate.

Shaded cells indicate that the family was not among the top five dominant families for that site.

See Section 5.3.1.6 for the explanation of stations with fewer than five families.

5.3.2 Fish Data

Fish data are summarized in tabular form in Appendix D (MDC unpublished data 2013) and may be addressed in a separate document. Reference to impairment in Appendix D uses criteria from wadeable/perennial streams in the Ozark Ecoregion and is not applicable to headwater streams (as stated in the Fish Community Section of the Methodology for the Development of the 2016 Section 303(d) List in Missouri {see <http://dnr.mo.gov/env/wpp/waterquality/docs/2016-lmd-for-cwc-approval-w-track-changes.pdf>}).

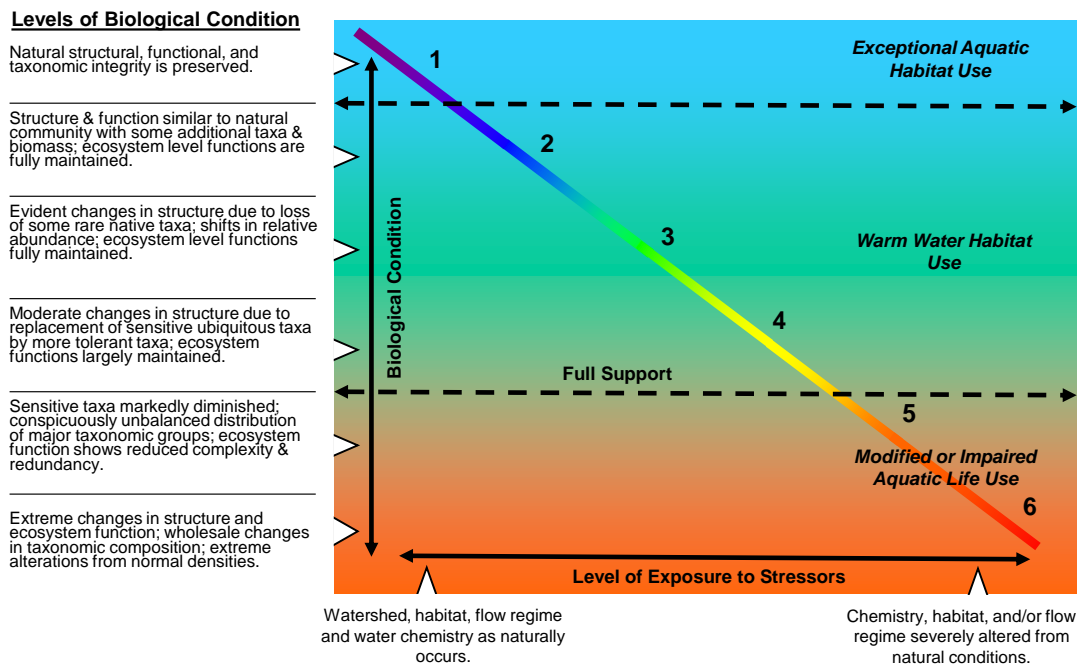
6.0 Discussion

Narrative criteria in the Missouri Water Quality Standards, 10 CSR 20 – 7.031 (4) (G), state “Waters shall be free from physical, chemical, or hydrologic changes that would impair the natural biological community” (MDNR 2014). This study demonstrates evidence that physical changes to the natural habitat impair the natural biological community.

Results from this study tend to support the Biological Condition Gradient in Figure 7 (adapted from United States Environmental Protection Agency {2005}) where macroinvertebrate communities respond to increased levels of stress from altered habitats. This figure presents a graphic representation and specifies narrative criteria language for how the gradient would fit Missouri Aquatic Life Use Designations for Exceptional Aquatic Habitat, Warm Water Aquatic Habitat, and Modified Habitat, or Impaired Aquatic Communities.

Figure 7

The Biological Condition Gradient: Biological Response to Increasing Levels of Stress



The only study sample to have a fully supporting ranking was from a station that had all three habitats and some natural substrate with vegetation. Even though both Trib. to Joplin Creek Station #4 samples and the fall Trib. to Silver Creek #2 sample (both sites with concrete-only substrates) received partially supporting rankings, most of the partially supporting rankings came from stations with at least some natural substrate or concrete-only substrate stations that were old enough to have some cover such as loose concrete and grassy patches. All study samples with non-supporting rankings were from

stations completely altered by paved bottom and banks with no riparian zone vegetative cover.

Habitat assessments and instream measurements exhibit apparent differences between available instream epifaunal habitats, maximum and average depths, and depth heterogeneity between highly modified and unmodified stream segments. All of these factors affect the ability of macroinvertebrate communities to colonize and inhabit a segment of stream.

As mentioned in Section 5.3.1.2, metrics such as TR tend to score lower in the most heavily modified streams while the BI metric scored better in the more modified streams. The BI is a measure of the sensitivity (or tolerance) of a taxon to organic pollutants. It is possible to have relatively few taxa in a highly modified stream segment that are nevertheless fairly sensitive to poor water quality. These same sensitive taxa may, however, be adaptable to poor habitat conditions, especially in the absence of a broader range of taxa that may provide more competition and/or predation.

The notably low scores for TR as well as EPTT combined with high BI scores are suggestive of issues that are apart from water quality. In an unmodified stream, macroinvertebrates have multiple structural possibilities for habitat such as gravel and other rocky substrate, woody material, substrate suitable for burrowing, RM, overhanging banks, and vegetation. They can use these habitats for shelter, cover from predators, surfaces to cling to, and more structure simply provides more surface area to accommodate a larger and more diverse macroinvertebrate population. In a modified stream, especially a stream where the bottom and banks are all concrete and there is no cover beyond benthic algae, all of these aforementioned sources of habitat structure are absent.

7.0 Conclusions

Based on this study, there may be a conclusion drawn that streams with highly modified channels are not biologically sustainable. It may also be concluded that typically the more modified the stream, the more impairment exhibited. For example, a stream segment that is paved only at the banks while still having a substrate that is all, or to some degree natural, is more likely to be less impaired than a fully paved stream channel.

Another conclusion from this study is that modifications of instream habitat, such as those in urban areas where the stream channel is completely replaced with pavement for storm water management purposes, results in considerably degraded habitat available for biological communities. This habitat degradation is manifested in physical changes that impair the natural community.

8.0 Summary

- The null hypothesis that macroinvertebrate assemblages are similar between Joplin area study streams and candidate reference streams is rejected.

- The null hypothesis that macroinvertebrate assemblages are similar between study stream stations with modified habitats and stream stations with unmodified habitats is rejected.
- The null hypothesis that macroinvertebrate assemblages are similar between Trib. to Joplin Creek and Trib. to Silver Creek stream segments is rejected.
- The null hypothesis that macroinvertebrate assemblages will not differ between the two sample seasons is rejected.
- The null hypothesis that there will be no apparent differences in habitats between modified and unmodified stream segments is rejected.

9.0 Literature Cited

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Submitted by:



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Date:



Approved by:



Alan Reinkemeyer, Director
Environmental Services Program

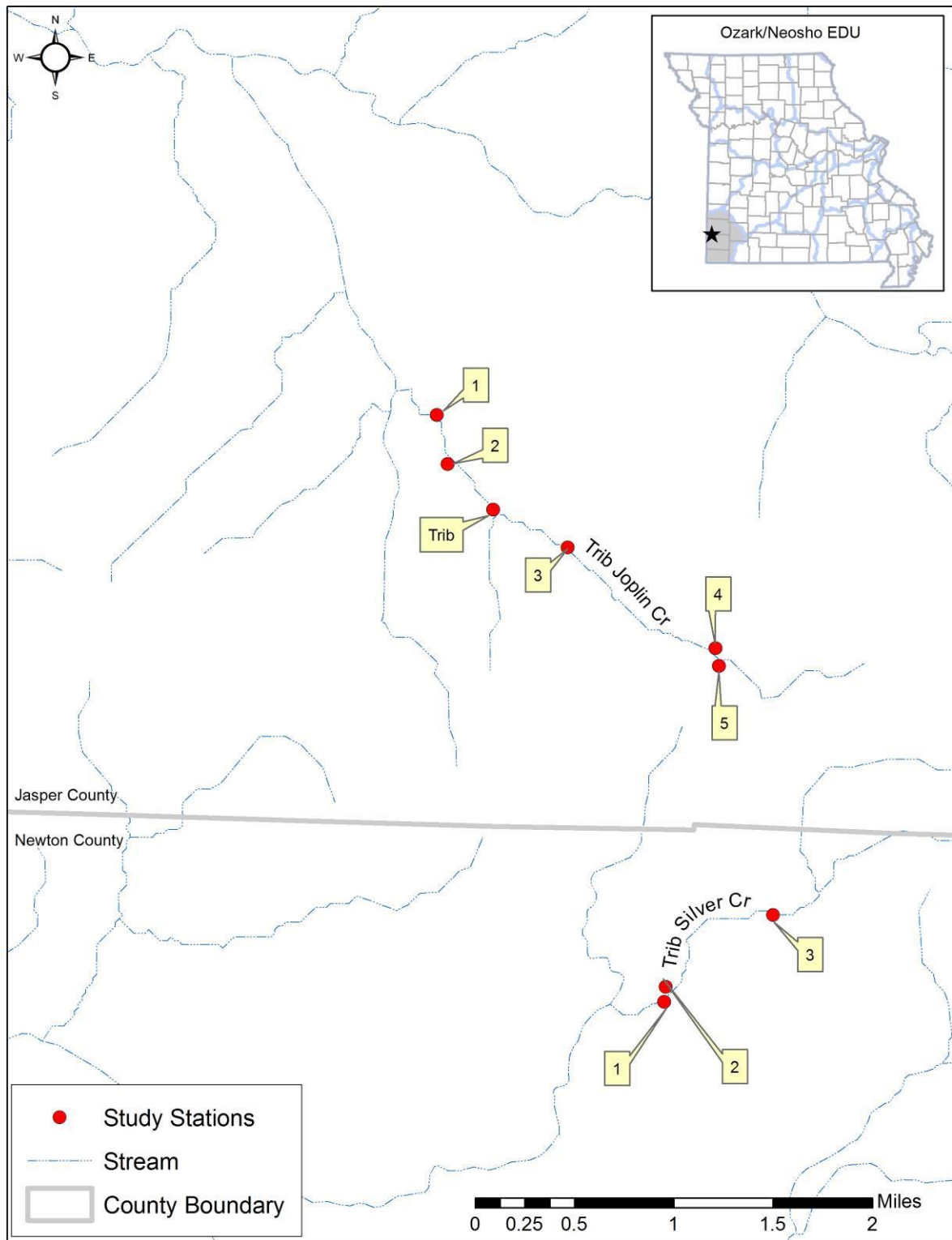
AR:bnt

cc: Cindy Davies, Regional Director, SWRO
Trish Rielly, Quality Assurance Project Plan Project Manager, WPP

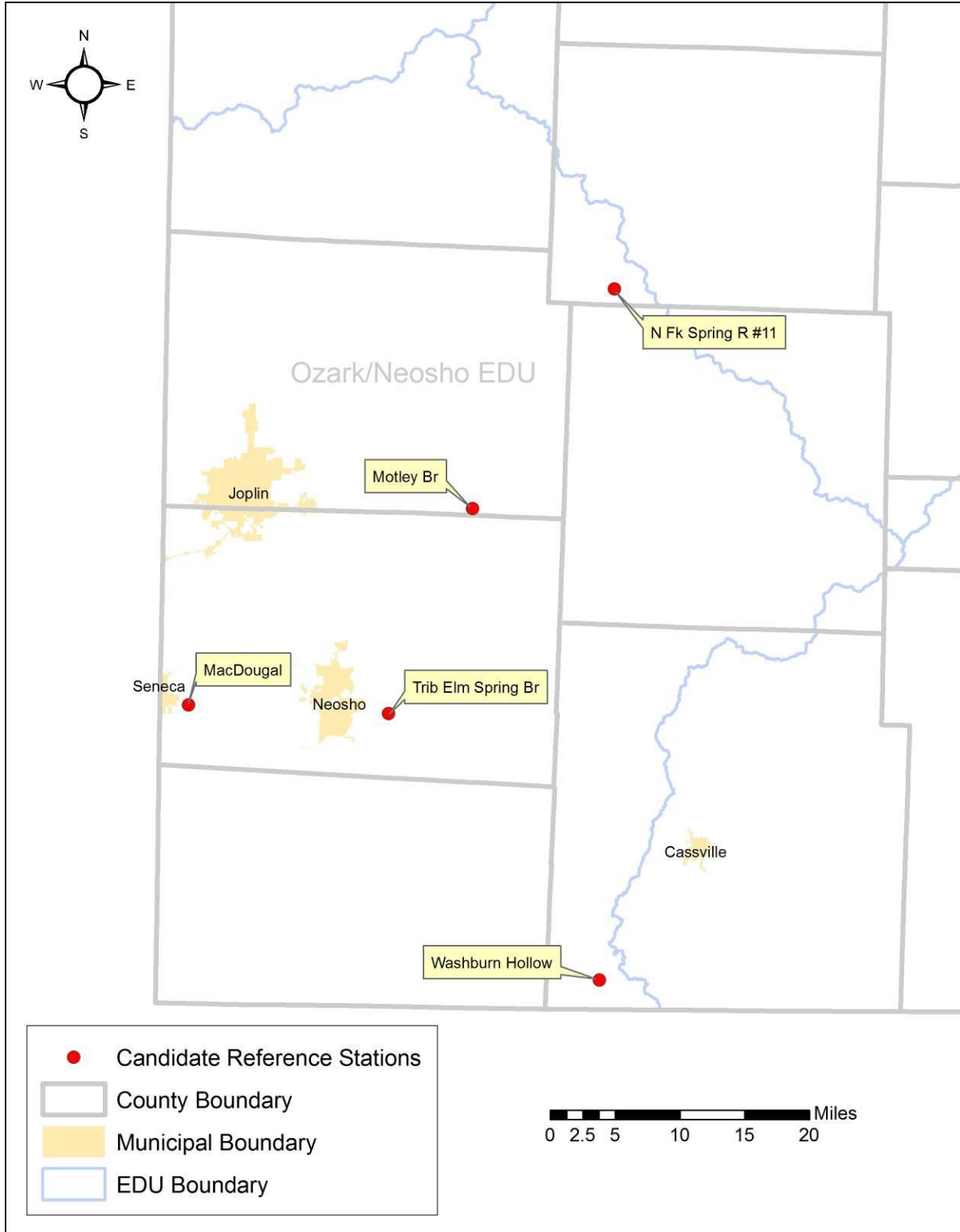
Appendix A

Study Area Maps

Joplin Modified Headwater Study Stations



Candidate Reference Stations



Appendix B

Images of Sample Stations

Trib. to Silver Creek #1, Upstream View
June 17, 2014



Trib. to Silver Creek #2, Upstream View
June 17, 2014



Trib. to Silver Creek #3, Upstream View
June 17, 2014



Trib. to Joplin Creek #1, Downstream View
June 17, 2014



Trib. to Joplin Creek #2, Upstream View
June 17, 2014



Trib. to Joplin Creek #3, Upstream View
June 17, 2014



Trib. to Joplin Creek #4, Downstream View
June 18, 2014



Trib. to Joplin Creek #5, Downstream View
June 18, 2014



Trib. to Trib. of Joplin Creek, Upstream View
June 17, 2014



MacDougal Branch, Upstream View
June 18, 2014



Trib. to Elm Spring Branch, Downstream View
June 18, 2014



Washburn Hollow, Upstream View
June 18, 2014



North Fork Spring River #11, Downstream View
June 19, 2014



Appendix C

Macroinvertebrate Bench Sheets

Aquid Invertebrate Database Bench Sheet Report**Trib. Silver Cr [131922], Station #1, Sample Date: 4/9/2013 11:00:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina		4	
ARHYNCHOBDELLIDA			
Erpobdellidae	5	2	1
BASOMMATOPHORA			
Helisoma		-99	
Lymnaeidae			2
Physella	26	85	12
Planorbella		6	
COLEOPTERA			
Berosus	1		1
Dytiscidae			1
Optioservus sandersoni			1
Stenelmis	105	2	3
DECAPODA			
Orconectes neglectus	-99	1	1
DIPTERA			
Ceratopogoninae		2	
Cricotopus bicinctus	3	1	2
Cricotopus/Orthocladius	126	22	7
Cryptochironomus		1	1
Dicrotendipes	3	4	
Ephydriidae			1
Limonia	1		
Polypedilum convictum			1
Polypedilum scalaenum grp	1	1	
Pseudochironomus	28	28	16
Rheotanytarsus	4		
Sciomyzidae			1
Tanytarsus		1	
Thienemannimyia grp.	2		
EPHEMEROPTERA			
Fallceon	2		
Stenonema femoratum	4	3	
LUMBRICINA			
Lumbricina	1	2	
ODONATA			
Argia	6	2	
TRICLADIDA			

Aquid Invertebrate Database Bench Sheet Report**Trib. Silver Cr [131922], Station #1, Sample Date: 4/9/2013 11:00:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Planariidae	220	16	80
TUBIFICIDA			
Enchytraeidae		1	
Limnodrilus hoffmeisteri	2	34	1
Tubificidae	3	66	
VENEROIDA			
Pisidiidae		7	1

Aquid Invertebrate Database Bench Sheet Report**Trib. Silver Cr [131923], Station #2, Sample Date: 4/9/2013 12:00:00 PM****CC = Concrete; -99 = Presence**

ORDER: TAXA	CC
COLEOPTERA	
Stenelmis	1
DIPTERA	
Chironomidae	1
Cricotopus bicinctus	4
Cricotopus/Orthocladius	343
Dicrotendipes	8
Paratanytarsus	1
Paratendipes	1
Pseudochironomus	230
Rheotanytarsus	1
Tanytarsus	1
TRICLADIDA	
Planariidae	2

Aquid Invertebrate Database Bench Sheet Report**Trib. Silver Cr [131924], Station #3, Sample Date: 4/9/2013 12:45:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
AMPHIPODA			
Stygobromus	6	4	
BASOMMATOPHORA			
Ancylidae		1	
Lymnaeidae	2	2	3
Physella	8	3	4
COLEOPTERA			
Dytiscidae			1
Stenelmis	36	72	4
DIPTERA			
Ablabesmyia		3	
Ceratopogoninae		1	
Cricotopus/Orthocladius	3	8	2
Dicrotendipes	1	2	
Diptera		3	
Polypedilum halterale grp		1	
Pseudochironomus		2	
Smittia		2	
Zavreliomyia		1	
EPHEMEROPTERA			
Leptophlebia		1	
Stenonema femoratum	15	6	7
HAPLOTAXIDA			
Haplotaxis		2	
ISOPODA			
Caecidotea (Blind & Unpigmented)		2	
LUMBRICULIDA			
Lumbriculidae		9	
TRICLADIDA			
Planariidae	20	7	1
TUBIFICIDA			
Enchytraeidae	5	28	1
Tubificidae		32	
VENEROIDA			
Pisidiidae	1	1	

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [131925], Station #1, Sample Date: 4/9/2013 2:00:00 PM****CS = Coarse; NF = Nonflow; -99 = Presence**

ORDER: TAXA	CS	NF
BASOMMATOPHORA		
Physella		1
Planorbella		1
COLEOPTERA		
Berosus	1	2
Stenelmis	98	
DIPTERA		
Ablabesmyia		21
Chironomidae		1
Cricotopus bicinctus	16	1
Cricotopus/Orthocladius	375	27
Cryptochironomus		31
Dicrotendipes	3	12
Eukiefferiella	2	
Hemerodromia	2	
Larsia	2	3
Limnophyes	1	
Limonia	1	
Polypedilum scalaenum grp		3
Pseudochironomus	50	33
Thienemannimyia grp.	8	1
EPHEMEROPTERA		
Baetis	1	
Caenis latipennis	1	12
Stenonema femoratum	-99	4
ISOPODA		
Caecidotea (Blind & Unpigmented)		1
LUMBRICINA		
Lumbricina	4	4
ODONATA		
Argia	7	3
TRICLADIDA		
Planariidae	34	21
TUBIFICIDA		
Branchiura sowerbyi		27
Enchytraeidae	3	1
Limnodrilus hoffmeisteri	1	23
Tubificidae	4	14
VENEROIDA		

Aquid Invertebrate Database Bench Sheet Report

Trib. Joplin Cr [131925], Station #1, Sample Date: 4/9/2013 2:00:00 PM

CS = Coarse; NF = Nonflow; -99 = Presence

ORDER: TAXA	CS	NF
Pisidiidae		1

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [131926], Station #2, Sample Date: 4/9/2013 2:50:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
ARHYNCHOBDELLIDA			
Erpobdellidae		1	2
BASOMMATOPHORA			
Ancylidae	6	4	1
Helisoma		-99	1
Physella		3	175
Planorbella		1	
COLEOPTERA			
Berosus	4	4	
Stenelmis	28	21	
DECAPODA			
Orconectes neglectus		1	
Orconectes virilis			-99
DIPTERA			
Ceratopogoninae		1	
Chironomidae		1	
Cricotopus bicinctus	7		1
Cricotopus/Orthocladius	484	48	64
Cryptochironomus		1	
Dicrotendipes		4	
Diptera		1	
Eukiefferiella	6		
Hemerodromia	1		
Larsia		1	
Limonia	1		
Micropsectra		1	
Parametriocnemus	3		
Paratanytarsus	3	3	
Paratendipes		1	
Polypedilum convictum	2		
Polypedilum scalaenum grp		2	
Pseudochironomus	10	4	3
Simulium	2		
Tanytarsus	2		
Thienemannimyia grp.	7		1
EPHEMEROPTERA			
Baetis	2		2
Caenis latipennis	22	119	8
Fallceon	10		5
Maccaffertium pulchellum	1		1

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [131926], Station #2, Sample Date: 4/9/2013 2:50:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Stenonema femoratum	4	1	1
LUMBRICINA			
Lumbricina	3	12	
ODONATA			
Argia	16	1	10
Calopteryx			1
Enallagma			2
TRICHOPTERA			
Cheumatopsyche	2		
Hydropsyche	2		
Hydroptila	1		
TRICLADIDA			
Planariidae	40	43	3
TUBIFICIDA			
Enchytraeidae	3	1	
Limnodrilus hoffmeisteri	2	2	
Tubificidae	2	6	
VENEROIDA			
Pisidiidae			1

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [131928], Station #3, Sample Date: 4/9/2013 4:15:00 PM****CC = Concrete; -99 = Presence**

ORDER: TAXA	CC
ARHYNCHOBDELLIDA	
Erpobdellidae	6
BASOMMATOPHORA	
Physella	2
COLEOPTERA	
Berosus	14
Stenelmis	1
DIPTERA	
Apedilum	46
Cricotopus bicinctus	6
Cricotopus/Orthocladius	346
Dicrotendipes	23
Forcipomyiinae	1
Polypedilum scalaenum grp	9
Pseudochironomus	103
Smittia	1
Tanytarsus	7
Thienemannimyia grp.	1
EPHEMEROPTERA	
Caenis latipennis	17
Fallceon	1
Stenonema femoratum	2
ODONATA	
Argia	8
Enallagma	1
Libellula	1
TRICLADIDA	
Planariidae	4
TUBIFICIDA	
Limnodrilus hoffmeisteri	1
Tubificidae	8
VENEROIDA	
Pisidiidae	2

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [131929], Station #4, Sample Date: 4/9/2013 4:55:00 PM****CC = Concrete; -99 = Presence**

ORDER: TAXA	CC
DIPTERA	
Apedilum	5
Ceratopogoninae	1
Cricotopus/Orthocladius	110
Dicrotendipes	9
Larsia	6
Micropsectra	11
Polypedilum scalaenum grp	1
Pseudochironomus	403
Thienemannimyia grp.	2
ODONATA	
Argia	1
TRICHOPTERA	
Hydroptilidae	4
TRICLADIDA	
Planariidae	124
TUBIFICIDA	
Enchytraeidae	6
Limnodrilus hoffmeisteri	16
Tubificidae	22
VENEROIDA	
Pisidiidae	1

Aquid Invertebrate Database Bench Sheet Report

Trib. Joplin Cr [131930], Station #5, Sample Date: 4/9/2013 5:20:00 PM

CC = Concrete; -99 = Presence

ORDER: TAXA		CC
DIPTERA		
Cricotopus/Orthocladius		3
Dicrotendipes		3
Pseudochironomus		100
TRICLADIDA		
Planariidae		60
TUBIFICIDA		
Tubificidae		2

Aquid Invertebrate Database Bench Sheet Report**Trib. Trib. Joplin Cr [131927], Station #1, Sample Date: 4/9/2013 3:40:00 PM****CC = Concrete; -99 = Presence**

ORDER: TAXA	CC
BASOMMATOPHORA	
Physella	-99
COLEOPTERA	
Stenelmis	6
DECAPODA	
Orconectes neglectus	-99
DIPTERA	
Apedilum	1
Cricotopus bicinctus	42
Cricotopus/Orthocladius	517
Dicrotendipes	15
Eukiefferiella	5
Micropsectra	7
Parametriocnemus	2
Paratanytarsus	37
Pseudochironomus	32
Simulium	1
Tanytarsus	6
Thienemanniella	2
Thienemannimyia grp.	3
EPHEMEROPTERA	
Baetis	2
Fallceon	1
ODONATA	
Argia	1
TRICHOPTERA	
Hydropsyche	3
TRICLADIDA	
Planariidae	2

Aquid Invertebrate Database Bench Sheet Report**Trib. Elm Spring Br [131908], Station #1, Sample Date: 4/3/2013 10:10:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA "			
Acarina		8	4
AMPHIPODA			
Gammarus	96	15	28
Hyaella azteca			4
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BASOMMATOPHORA			
Ancylidae		2	1
Physella	4	14	26
Planorbella			1
COLEOPTERA			
Dytiscidae		14	1
Ectopria nervosa	4	14	3
Optioservus sandersoni	50	3	2
Stenelmis	19	1	1
DECAPODA			
Orconectes neglectus	-99	-99	
DIPTERA			
Ceratopogoninae		4	1
Chironomidae		4	
Corynoneura	1	8	7
Cricotopus bicinctus		1	
Cricotopus/Orthocladius	36	21	12
Cryptochironomus	1	1	1
Cryptotendipes		2	1
Dicrotendipes		14	5
Diptera	1		
Dixa			1
Dixella			1
Hexatoma			1
Hydrobaenus		3	
Micropsectra	114	30	11
Microtendipes	3	8	2
Neozavrelia		2	
Nilotanytus	1	1	
Ormosia			1
Orthocladius (Symposiocladius)			1
Parakiefferiella		1	
Paramerina		2	13

Aquid Invertebrate Database Bench Sheet Report**Trib. Elm Spring Br [131908], Station #1, Sample Date: 4/3/2013 10:10:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Parametriocnemus	3	4	1
Paraphaenocladus			2
Paratanytarsus	5	18	39
Paratendipes		119	11
Polypedilum aviceps	14		2
Polypedilum fallax grp		3	
Polypedilum scalaenum grp		10	1
Polypedilum tritum			1
Procladius		1	
Pseudolimnophila			4
Psilometriocnemus			2
Rheotanytarsus			1
Simulium	21		28
Stempellinella	1	18	3
Stictochironomus		6	2
Tanytarsus	3	5	
Thienemanniella	2	2	6
Thienemannimyia grp.	42	18	19
Tipula	-99		-99
Tvetenia bavarica grp	19		22
Zavrelimyia		36	32
EPHEMEROPTERA			
Acentrella	6		2
Diphetor	24		41
Eurylophella		25	12
Fallceon	7		15
Leptophlebia			3
Leucrocuta	8	9	2
Stenacron		20	2
Stenonema femoratum	-99	2	1
HEMIPTERA			
Aquarius			-99
Microvelia			10
Sigara			8
ISOPODA			
Lirceus	6	3	8
LUMBRICINA			
Lumbricina	-99	-99	
LUMBRICULIDA			
Lumbriculidae	6	16	2
MEGALOPTERA			

Aquid Invertebrate Database Bench Sheet Report**Trib. Elm Spring Br [131908], Station #1, Sample Date: 4/3/2013 10:10:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Sialis		-99	
ODONATA			
Argia	5		1
Calopteryx			1
Stylogomphus albistylus	-99		-99
PLECOPTERA			
Agnetina capitata	26		
Amphinemura	3		
Clioperla clio			1
Leuctridae	75	25	8
Perlesta	13		
TRICHOPTERA			
Agapetus	3		1
Cheumatopsyche	22		
Chimarra	45		1
Hydropsyche	1		
Hydroptila		2	2
Ironoquia	1		1
Lype diversa	1		1
Polycentropus		5	
Pycnopsyche		-99	-99
TRICLADIDA			
Planariidae	12	1	
TUBIFICIDA			
Ilyodrilus templetoni		1	
Limnodrilus hoffmeisteri		1	
Tubificidae	1	23	
VENEROIDA			
Pisidiidae		3	

Aquid Invertebrate Database Bench Sheet Report**MacDougal Cr [131907], Station #1, Sample Date: 4/3/2013 9:00:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA "			
Acarina		4	8
AMPHIPODA			
Hyaella azteca			96
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BASOMMATOPHORA			
Ancylidae	1	14	9
Menetus		1	16
Physella			8
BRANCHIOBDELLIDA			
Branchiobdellida	2		1
COLEOPTERA			
Dubiraphia	1	4	15
Optioservus sandersoni	121	19	2
Psephenus herricki	28	6	2
Stenelmis	2		1
DECAPODA			
Orconectes macrus	-99		
Orconectes neglectus	-99	-99	-99
DIPTERA			
Ablabesmyia		3	
Brillia	1	1	1
Ceratopogoninae	1	1	1
Chironomidae	2		1
Chironomus		2	
Cladotanytarsus		2	
Clinocera		1	
Corynoneura		12	2
Cricotopus/Orthocladius	16	1	5
Cryptochironomus		1	
Cryptotendipes		1	
Dicrotendipes		1	3
Eukiefferiella	1		3
Hexatoma		-99	
Micropsectra	3	1	18
Microtendipes		4	2
Nanocladius			1
Nilotanypus	1		
Parametriocnemus	4		

Aquid Invertebrate Database Bench Sheet Report**MacDougal Cr [131907], Station #1, Sample Date: 4/3/2013 9:00:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Paratanytarsus		3	10
Paratendipes		27	
Polypedilum convictum	2		
Polypedilum scalaenum grp		5	1
Rheocricotopus	2		
Simulium	2		2
Stempellinella	1	1	
Synorthocladius			1
Thienemanniella	6	3	13
Thienemannimyia grp.	7	2	1
Tribelos		1	
Tvetenia bavarica grp	2		3
Tvetenia discoloripes grp	4		
Zavrelimyia		1	
EPHEMEROPTERA			
Acentrella	26		1
Acerpenna	1	3	4
Baetis	16		3
Centroptilum		1	2
Dipheter	95	5	13
Eurylophella bicolor			5
Fallceon	16	1	4
Leptophlebia		1	2
Leptophlebiidae	17	11	
Leucrocuta	40	20	2
Pseudocloeon			1
Stenacron	10	35	1
Stenonema femoratum	1	6	
ISOPODA			
Lirceus	26	66	18
LUMBRICINA			
Lumbricina		-99	3
LUMBRICULIDA			
Lumbriculidae	4	1	
NEOTAENIOGLOSSA			
Elimia	2	1	-99
ODONATA			
Boyeria			-99
Calopteryx			-99
Gomphidae		1	
PLECOPTERA			

Aquid Invertebrate Database Bench Sheet Report**MacDougal Cr [131907], Station #1, Sample Date: 4/3/2013 9:00:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Acroneuria	-99	-99	
Agnetina capitata	17	-99	
Amphinemura	1		
Leuctridae	26	3	1
Perlesta	17		
TRICHOPTERA			
Agapetus	3		
Cheumatopsyche	31		
Chimarra	2		
Helicopsyche	6		
Ochrotrichia	2		
Oxyethira			2
Polycentropus	5		
Pycnopsyche			1
Triaenodes			1
TRICLADIDA			
Planariidae	28	1	
TUBIFICIDA			
Limnodrilus hoffmeisteri		1	
Tubificidae	1	35	3
VENEROIDA			
Pisidiidae	2	2	3

Aquid Invertebrate Database Bench Sheet Report**Washburn Hollow [131906], Station #1, Sample Date: 4/2/2013 4:30:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	1		
BASOMMATOPHORA			
Physella	1	2	3
COLEOPTERA			
Dytiscus	1	-99	1
DECAPODA			
Orconectes williamsi	-99		
DIPTERA			
Ceratopogoninae	1		
Clinocera		1	
Corynoneura		7	3
Cricotopus/Orthocladius	66	14	5
Dicrotendipes	2	8	
Diptera		1	
Dolichopodidae	1		
Eukiefferiella	5		
Heterotrissocladius			1
Micropsectra		2	1
Parametriocnemus	3	1	
Paratanytarsus		1	
Prosimulium	1		
Sympothastia	3	1	
Synorthocladius	1		
Zavrelimyia		8	1
EPHEMEROPTERA			
Acentrella	10		
Ameletus	2	4	
Leptophlebiidae	1	4	
Siphonurus		29	20
ISOPODA			
Lirceus	211	235	159
LUMBRICULIDA			
Lumbriculidae	1	1	1
PLECOPTERA			
Amphinemura	98	8	2
Clioperla clio	2		
Haploperla	11	4	
Isoperla	121	9	2
Perlesta	7	5	

Aquid Invertebrate Database Bench Sheet Report**Washburn Hollow [131906], Station #1, Sample Date: 4/2/2013 4:30:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Zealeuctra	5	6	
TRICHOPTERA			
Ironoquia		-99	2
Rhyacophila	3	1	
TRICLADIDA			
Planariidae	7		
TUBIFICIDA			
Enchytraeidae	1	2	

Aquid Invertebrate Database Bench Sheet Report**Motley Br [131909], Station #1, Sample Date: 4/3/2013 11:45:00 AM****CS = Coarse; NF = Nonflow; -99 = Presence**

ORDER: TAXA	CS	NF
AMPHIPODA		
Hyaella azteca		5
COLEOPTERA		
Dytiscidae		5
Stenelmis	1	
DIPTERA		
Chironomidae	4	1
Corynoneura		1
Cricotopus/Orthocladius	22	4
Cryptochironomus		1
Diamesa	2	
Dicrotendipes	1	3
Diplocladius	3	
Diptera		17
Ephydriidae		3
Eukiefferiella	3	
Heterotrissocladius	24	47
Hydrobaenus	36	38
Micropsectra		25
Ormosia		1
Orthocladius (Euorthocladius)	7	
Parametriocnemus	8	3
Paraphaenocladius		1
Simulium	41	
Tabanidae		2
Tanytarsus	11	2
Thienemanniella	2	
Tipula	2	
Zavrelimyia		2
EPHEMEROPTERA		
Caenis latipennis	1	
Callibaetis	1	3
ISOPODA		
Lirceus	1	7
LEPIDOPTERA		
Crambidae	1	3
Noctuidae	1	1
PLECOPTERA		
Perlidae	4	
Perlodidae	2	

Aquid Invertebrate Database Bench Sheet Report**Motley Br [131909], Station #1, Sample Date: 4/3/2013 11:45:00 AM****CS = Coarse; NF = Nonflow; -99 = Presence**

ORDER: TAXA	CS	NF
Zealeuctra	66	39
TRICLADIDA		
Planariidae	2	4
TUBIFICIDA		
Enchytraeidae	195	100

Aquid Invertebrate Database Bench Sheet Report**North Fk Spring R [131910], Station #11, Sample Date: 4/3/2013 1:15:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	4		5
ARHYNCHOBDELLIDA			
Erpobdellidae	2	-99	-99
BASOMMATOPHORA			
Ancylidae	6		
Lymnaeidae			1
Menetus			2
Physella	-99	2	3
COLEOPTERA			
Berosus			1
Dubiraphia			2
Dytiscus			1
Peltodytes			1
Psephenus herricki	6		
Stenelmis	119	1	11
DECAPODA			
Orconectes neglectus	-99		
DIPTERA			
Ablabesmyia		2	1
Ceratopogoninae	2	12	
Chrysops			1
Cladopelma		13	
Corynoneura	1	1	
Cricotopus/Orthocladius	100	1	16
Cryptochironomus	1	1	
Cryptotendipes		17	
Dicrotendipes	6	33	10
Diplocladius	5		3
Diptera		1	
Forcipomyiinae		1	
Hydrobaenus	5	28	26
Micropsectra	18	1	31
Nanocladius	1		15
Parametriocnemus	2		3
Paratanytarsus	1		1
Paratendipes	3	102	4
Phaenopsectra	1		
Polypedilum convictum	103		18
Polypedilum halterale grp	2	3	

Aquid Invertebrate Database Bench Sheet Report**North Fk Spring R [131910], Station #11, Sample Date: 4/3/2013 1:15:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Polypedilum illinoense grp	1		6
Polypedilum scalaenum grp	35	5	1
Procladius		1	
Pseudochironomus			1
Rheocricotopus			6
Rheotanytarsus	14		9
Stempellinella	4	4	4
Tanytarsus	308	90	180
Thienemanniella	1		
Thienemannimyia grp.	2		2
Tipula			-99
Tribelos	1		
Tvetenia bavarica grp			1
Zavrelimyia	2	1	1
EPHEMEROPTERA			
Caenis latipennis	14	24	24
Hexagenia limbata		-99	
Stenonema femoratum	8	-99	-99
HEMIPTERA			
Corixidae		1	
LUMBRICINA			
Lumbricina		-99	
MEGALOPTERA			
Sialis		-99	
ODONATA			
Argia			3
Calopteryx			-99
Dromogomphus			-99
Enallagma			4
Epithea (Epicordulia)		-99	
Erythemis			-99
Libellula			-99
Stylogomphus albistylus			-99
TRICHOPTERA			
Chimarra	1		
Rhyacophila	1	1	
TRICLADIDA			
Planariidae	39		4
TUBIFICIDA			
Enchytraeidae	3	1	

Aquid Invertebrate Database Bench Sheet Report**North Fk Spring R [131910], Station #11, Sample Date: 4/3/2013 1:15:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Ilyodrilus templetoni	1		
Limnodrilus hoffmeisteri	4	2	1
Tubificidae	9	12	5
VENEROIDA			
Corbicula	1		
Pisidiidae	7	3	1

Aquid Invertebrate Database Bench Sheet Report**Trib. Silver Cr [132007], Station #1, Sample Date: 9/24/2013 11:05:00 AM****CS = Coarse; NF = Nonflow; -99 = Presence**

ORDER: TAXA	CS	NF
ARHYNCHOBDELLIDA		
Erpobdellidae	-99	4
BASOMMATOPHORA		
Lymnaeidae	1	
Physella		1
COLEOPTERA		
Berosus	6	5
Dubiraphia	1	5
Psephenus herricki	-99	
Stenelmis	117	7
DECAPODA		
Orconectes neglectus	1	-99
Orconectes virilis		1
DIPTERA		
Ablabesmyia		3
Apedilum	1	2
Ceratopogoninae	7	1
Chironomus		42
Clinotanypus		1
Cricotopus bicinctus	1	
Cricotopus/Orthocladius	15	
Cryptochironomus	9	5
Dicrotendipes		3
Forcipomyiinae	8	1
Paratanytarsus	1	
Paratendipes	10	60
Pentaneura	5	
Polypedilum convictum	10	
Polypedilum illinoense grp	2	
Polypedilum scalaenum grp	88	12
Procladius		5
Pseudochironomus	15	10
Tanypus		20
Tanytarsus	14	7
Thienemannimyia grp.	21	
EPHEMEROPTERA		
Baetis	3	
Caenis latipennis	3	
Callibaetis		2
Fallceon	151	1

Aquid Invertebrate Database Bench Sheet Report**Trib. Silver Cr [132007], Station #1, Sample Date: 9/24/2013 11:05:00 AM****CS = Coarse; NF = Nonflow; -99 = Presence**

ORDER: TAXA	CS	NF
Heptageniidae	1	
Stenonema femoratum	11	46
Tricorythodes	2	
HEMIPTERA		
Belostoma		1
LUMBRICINA		
Lumbricina		1
ODONATA		
Argia	67	2
Enallagma		1
Libellulidae	1	3
Pantala		-99
Plathemis		-99
RHYNCHOBDELLIDA		
Glossiphoniidae		19
TRICHOPTERA		
Hydroptila	13	
TRICLADIDA		
Planariidae	63	6
TUBIFICIDA		
Limnodrilus hoffmeisteri	3	14
Tubificidae	23	48
VENEROIDA		
Pisidiidae	1	2

Aquid Invertebrate Database Bench Sheet Report**Trib. Silver Cr [132008], Station #2, Sample Date: 9/24/2013 12:00:00 PM****CC = Concrete; -99 = Presence**

ORDER: TAXA	CC
ARHYNCHOBDELLIDA	
Erpobdellidae	-99
COLEOPTERA	
Berosus	3
Enochrus	1
Laccophilus	1
Stenelmis	1
DIPTERA	
Apedilum	3
Ceratopogoninae	1
Cricotopus/Orthocladius	36
Cryptochironomus	1
Pentaneura	4
Polypedilum convictum	3
Polypedilum scalaenum grp	6
Pseudochironomus	128
Tanytarsus	2
Thienemannimyia grp.	2
EPHEMEROPTERA	
Fallceon	111
TRICHOPTERA	
Hydroptila	11
TRICLADIDA	
Planariidae	49
TUBIFICIDA	
Tubificidae	2

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [132009], Station #1, Sample Date: 9/24/2013 1:45:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA "			
Acarina		1	
BASOMMATOPHORA			
Ancylidae	4	1	1
Helisoma		-99	-99
Lymnaeidae	1		
Menetus	2		7
Physella	14	8	128
Planorbella		1	1
COLEOPTERA			
Berosus	5	1	4
Paracymus			1
Stenelmis	3		
DIPTERA			
Ablabesmyia	6	5	
Aedes			1
Apedilum	12		1
Cricotopus/Orthocladius	46	8	
Cryptochironomus		6	
Dasyheleinae	1		
Dicrotendipes	3	6	10
Forcipomyiinae	4		
Hemerodromia	3		
Labrundinia	1		2
Nanocladius	2		
Paratanytarsus	3	1	6
Polypedilum convictum	2		
Polypedilum illinoense grp	3		
Polypedilum scalaenum grp		1	
Procladius		2	
Pseudochironomus	6	31	11
Rheotanytarsus	2		
Tanytarsus	5	1	2
Thienemanniella	3		
Thienemannimyia grp.	17		
EPHEMEROPTERA			
Baetis	10		
Caenis latipennis	130	224	
Callibaetis			2
Fallceon	99		

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [132009], Station #1, Sample Date: 9/24/2013 1:45:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Leptophlebiidae		3	
Maccaffertium pulchellum	3		
Stenonema femoratum	22	1	
HEMIPTERA			
Microvelia	3		
LUMBRICINA			
Lumbricina	7	-99	
ODONATA			
Argia	261	6	11
Enallagma		5	67
Erythemis			-99
Hetaerina	13		
Ischnura			7
TRICHOPTERA			
Cheumatopsyche	4		
Hydroptila	5		
TRICLADIDA			
Planariidae	21		
TUBIFICIDA			
Branchiura sowerbyi		4	
Tubificidae	7	13	

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [132010], Station #2, Sample Date: 9/24/2013 2:28:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BASOMMATOPHORA			
Ancylidae	1	2	4
Helisoma			3
Lymnaeidae	1		
Physella	2	1	131
Planorbella			5
COLEOPTERA			
Berosus	1	1	2
Stenelmis	10		
DECAPODA			
Orconectes neglectus	1		1
DIPTERA			
Ablabesmyia		4	
Apedilum	1		
Ceratopogoninae			1
Chironomidae	1		
Cladotanytarsus	1	1	
Corynoneura	2		1
Cricotopus bicinctus	1		7
Cricotopus/Orthocladius	26	1	2
Cryptochironomus	1	1	
Dicrotendipes	2	8	8
Diptera	3		
Forcipomyiinae		1	
Hemerodromia	1		
Paratanytarsus	7	2	26
Polypedilum convictum	12		
Polypedilum illinoense grp	3		1
Polypedilum scalaenum grp	1		
Procladius		5	
Pseudochironomus		1	1
Rheotanytarsus	13	5	
Simulium	3		1
Stempellinella		2	
Tanypus		1	
Tanytarsus	5	4	4
Thienemanniella	4		1
Thienemannimyia grp.	7		1

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [132010], Station #2, Sample Date: 9/24/2013 2:28:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
EPHEMEROPTERA			
Baetis	21		
Caenis latipennis	349	667	45
Callibaetis			1
Fallceon	26		7
Stenonema femoratum	11	8	2
LUMBRICINA			
Lumbricina	5	4	
ODONATA			
Argia	91	1	12
Enallagma	2	2	41
Hetaerina	25		15
Ischnura			9
TRICHOPTERA			
Cheumatopsyche	27		2
Hydropsyche	1		
Hydroptila	1		1
TRICLADIDA			
Planariidae	26	1	3
TUBIFICIDA			
Tubificidae	2	9	
VENEROIDA			
Pisidiidae		2	

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [132012], Station #3, Sample Date: 9/24/2013 3:40:00 PM****CC = Concrete; -99 = Presence**

ORDER: TAXA	CC
BASOMMATOPHORA	
Physella	3
COLEOPTERA	
Berosus	21
DIPTERA	
Chironomus	4
Cladotanytarsus	3
Cricotopus bicinctus	3
Cricotopus/Orthocladius	36
Cryptochironomus	4
Dicrotendipes	6
Polypedilum convictum	1
Polypedilum scalaenum grp	3
Pseudochironomus	11
Tanytarsus	17
Thienemannimyia grp.	4
EPHEMEROPTERA	
Baetis	6
Caenis latipennis	94
Fallceon	65
ODONATA	
Pantala	-99
TRICHOPTERA	
Hydroptila	1
TUBIFICIDA	
Tubificidae	9

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [132013], Station #4, Sample Date: 9/24/2013 4:05:00 PM****CC = Concrete; -99 = Presence**

ORDER: TAXA	CC
BASOMMATOPHORA	
Physella	13
COLEOPTERA	
Berosus	2
DIPTERA	
Apedilum	28
Cladotanytarsus	61
Cricotopus bicinctus	2
Cricotopus/Orthocladius	140
Dicrotendipes	2
Larsia	1
Paratendipes	1
Pseudochironomus	59
Tanypus	23
Tanytarsus	3
EPHEMEROPTERA	
Caenis latipennis	1
Fallceon	22
TRICHOPTERA	
Hydroptila	1
TRICLADIDA	
Planariidae	12
TUBIFICIDA	
Aulodrilus	4
Limnodrilus hoffmeisteri	2
Tubificidae	5
VENEROIDA	
Pisidiidae	10

Aquid Invertebrate Database Bench Sheet Report**Trib. Joplin Cr [132014], Station #5, Sample Date: 9/24/2013 4:20:00 PM****CC = Concrete; -99 = Presence**

ORDER: TAXA	CC
BASOMMATOPHORA	
Physella	1
DIPTERA	
Apedilum	37
Chironomidae	1
Cladotanytarsus	1
Cricotopus/Orthocladius	35
Cryptochironomus	1
Dicrotendipes	202
Larsia	4
Pseudochironomus	50
Tanytarsus	3
EPHEMEROPTERA	
Fallceon	8
ODONATA	
Argia	3
TRICHOPTERA	
Hydroptila	1
TRICLADIDA	
Planariidae	19

Aquid Invertebrate Database Bench Sheet Report**Trib. Trib. Joplin Cr [132011], Station #1, Sample Date: 9/24/2013 3:10:00 PM****CC = Concrete; -99 = Presence**

ORDER: TAXA	CC
DECAPODA	
Orconectes neglectus	1
Orconectes virilis	1
DIPTERA	
Ceratopogoninae	2
Chironomus	8
Cricotopus/Orthocladius	113
Cryptochironomus	1
Dicrotendipes	5
Paratanytarsus	24
Pseudochironomus	2
Psychodidae	1
Tanytarsus	7
Thienemannimyia grp.	2
Tipula	1
EPHEMEROPTERA	
Baetis	45
Caenis latipennis	8
Fallceon	5
HEMIPTERA	
Corixidae	2
Microvelia	5
ISOPODA	
Lirceus	1
TRICHOPTERA	
Cheumatopsyche	1
Hydroptila	4
VENEROIDA	
Pisidiidae	5

Aquid Invertebrate Database Bench Sheet Report**Trib. Elm Spring Br [132015], Station #1, Sample Date: 9/25/2013 10:20:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	2	36	4
AMPHIPODA			
Gammarus	195	48	59
Hyaella azteca			29
ARHYNCHOBDELLIDA			
Erpobdellidae		1	
BASOMMATOPHORA			
Ancylidae	1	3	
Physella			5
COLEOPTERA			
Dubiraphia		15	8
Ectopria nervosa	2	11	
Heterosternuta			1
Optioservus sandersoni	67	2	
Stenelmis	11	1	1
DECAPODA			
Orconectes neglectus	3	-99	-99
DIPTERA			
Brillia	1		
Ceratopogoninae		11	1
Clinocera	4		1
Corynoneura	2		
Cricotopus/Orthocladius	2	1	1
Culicidae			1
Dixella	1		2
Ephydriidae			5
Heterotrissocladius			1
Hexatoma	-99		
Micropsectra	20	1	50
Microtendipes	5	10	3
Natarsia		1	
Neozavrelia	1		
Orthocladius (Symposiocladius)	1		
Paramerina			3
Parametriocnemus	13		
Paratendipes		4	
Polypedilum aviceps	52		
Polypedilum illinoense grp	2		
Polypedilum tritum	1		2

Aquid Invertebrate Database Bench Sheet Report**Trib. Elm Spring Br [132015], Station #1, Sample Date: 9/25/2013 10:20:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Rheotanytarsus	8		
Simulium	5		
Stempellinella	20	36	9
Stictochironomus		2	
Tanytarsus		1	
Thienemanniella			2
Thienemannimyia grp.	14		5
Tipula	10		
Tvetenia bavarica grp	13		
Tvetenia discoloripes grp	3		
Zavrelimyia	1	13	5
EPHEMEROPTERA			
Baetis			1
Dipheter	9		
Eurylophella	1	2	3
Fallceon	9		1
Leptophlebiidae	2	24	48
Leucrocuta	10		
Stenacron	9	13	
Stenonema femoratum		11	
HEMIPTERA			
Microvelia	13		12
Sigara		2	2
ISOPODA			
Lirceus	7	6	3
LUMBRICINA			
Lumbricina		1	
LUMBRICULIDA			
Lumbriculidae	12	4	
MEGALOPTERA			
Sialis		3	
ODONATA			
Argia	2		4
Calopteryx			3
Hetaerina	2		8
Stylogomphus albistylus	2	1	
PLECOPTERA			
Agnetina capitata	4		
Leuctridae	3		
Perlesta	76	1	

Aquid Invertebrate Database Bench Sheet Report**Trib. Elm Spring Br [132015], Station #1, Sample Date: 9/25/2013 10:20:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
RHYNCHOBDELLIDA			
Glossiphoniidae			1
TRICHOPTERA			
Cheumatopsyche	66		1
Chimarra	33		
Polycentropus	6	1	12
Pycnopsyche		1	1
TRICLADIDA			
Planariidae	22		4
TUBIFICIDA			
Limnodrilus hoffmeisteri		3	
Tubificidae	7	27	
VENEROIDA			
Pisidiidae	1	31	1

Aquid Invertebrate Database Bench Sheet Report**MacDougal Cr [132016], Station #1a, Sample Date: 9/25/2013 8:45:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA "			
Acarina	2	11	2
AMPHIPODA			
Hyaella azteca		1	1
ARHYNCHOBDELLIDA			
Erpobdellidae	-99		
BASOMMATOPHORA			
Ancylidae		1	
Physella			11
COLEOPTERA			
Dubiraphia		6	3
Ectopria nervosa		11	
Optioservus sandersoni	57	7	4
Psephenus herricki	39	36	1
Stenelmis	4	2	
DECAPODA			
Orconectes macrus	-99	-99	
Orconectes neglectus	-99		-99
Orconectes virilis		-99	
DIPTERA			
Apedilum	1		
Brillia		2	1
Chironomus		2	
Chrysops		1	
Cryptochironomus		8	
Cryptotendipes		1	
Ephydriidae			6
Hexatoma	1		
Micropsectra	3		7
Microtendipes		8	
Natarsia		1	
Paralauterborniella		2	
Paramerina			2
Parametriocnemus	1		1
Paratendipes		34	
Polypedilum aviceps	9		1
Polypedilum convictum	1		
Polypedilum scalaenum grp		25	
Procladius		4	
Rheocricotopus			1

Aquid Invertebrate Database Bench Sheet Report**MacDougal Cr [132016], Station #1a, Sample Date: 9/25/2013 8:45:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Rheotanytarsus	8		10
Sciomyzidae			1
Simulium	10		4
Stempellinella	2	5	1
Tanytarsus		3	
Thienemanniella		1	1
Thienemannimyia grp.	7	1	1
Tribelos		2	
Tvetenia bavarica grp	7		1
Zavrelimyia		5	
EPHEMEROPTERA			
Acentrella	13		
Acerpenna	3	10	44
Baetis	54		7
Caenis latipennis		9	
Dipheter	101	14	36
Ephemera simulans		1	
Fallceon	2		
Isonychia bicolor	2		
Leptophlebiidae	1	5	
Leucrocuta	15	9	
Maccaffertium pulchellum		1	
Pseudocloeon			15
Stenacron		18	
Stenonema femoratum		4	
Tricorythodes		1	2
HEMIPTERA			
Corixidae		1	
ISOPODA			
Lirceus	37	14	45
LUMBRICINA			
Lumbricina	1	-99	
LUMBRICULIDA			
Lumbriculidae		1	
MEGALOPTERA			
Corydalus	-99		
Nigronia serricornis	-99		
Sialis		-99	
NEOTAENIOGLOSSA			
Elimia	-99	1	1

Aquid Invertebrate Database Bench Sheet Report**MacDougal Cr [132016], Station #1a, Sample Date: 9/25/2013 8:45:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Hydrobiidae			1
ODONATA			
Argia	2		
Boyeria	-99		
Calopteryx			10
Gomphidae	2	1	
PLECOPTERA			
Acroneuria	6	3	
Agnetina capitata	27		
Zealeuctra	4		1
RHYNCHOBDELLIDA			
Glossiphoniidae	1		
TRICHOPTERA			
Cheumatopsyche	166	1	9
Chimarra	28		
Helicopsyche	10	2	
Oxyethira			3
Polycentropus	8		2
Psychomyia	1		
TRICLADIDA			
Planariidae	38		5
TUBIFICIDA			
Aulodrilus		1	
Ilyodrilus templetoni		1	
Limnodrilus hoffmeisteri		6	
Tubificidae	2	21	
VENEROIDA			
Pisidiidae		5	

Aquid Invertebrate Database Bench Sheet Report**MacDougal Cr [132017], Station #1b, Sample Date: 9/25/2013 8:45:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA"			
Acarina	6	28	9
AMPHIPODA			
Hyaella azteca		1	52
Stygobromus		2	
ARHYNCHOBDELLIDA			
Erpobdellidae	-99	-99	
BASOMMATOPHORA			
Ancylidae		1	2
Physella		1	8
BRANCHIOBDELLIDA			
Branchiobdellida	3	1	1
COLEOPTERA			
Dubiraphia		6	5
Ectopria nervosa	2	7	
Optioservus sandersoni	144	10	3
Psephenus herricki	74	23	
Stenelmis	5		
DECAPODA			
Orconectes macrus	1		
Orconectes neglectus	1	-99	-99
DIPTERA			
Anopheles			1
Brillia	2		
Ceratopogoninae		1	
Chironomus		4	
Cladotanytarsus		1	
Clinocera			1
Cricotopus/Orthocladius		1	
Cryptochironomus		8	
Ephydriidae			15
Hexatoma	1		
Micropsectra	4		14
Microtendipes	2		
Nilotanypus			1
Paramerina		2	6
Parametriocnemus	4		
Paratendipes		19	
Polypedilum aviceps			1
Polypedilum fallax grp		1	

Aquid Invertebrate Database Bench Sheet Report**MacDougal Cr [132017], Station #1b, Sample Date: 9/25/2013 8:45:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Polypedilum halterale grp		1	
Polypedilum illinoense grp			5
Polypedilum scalaenum grp		28	
Procladius		2	
Rheotanytarsus	5		21
Simulium	8		5
Stempellinella	10	3	1
Tanytarsus		3	
Thienemanniella			1
Thienemannimyia grp.	5	1	4
Tvetenia bavarica grp	1		3
Zavrelimyia		2	
EPHEMEROPTERA			
Acentrella	6		
Acerpenna	8	15	48
Baetis	82	2	11
Caenis latipennis		9	
Choroterpes	9	7	1
Dipheter	80	12	17
Fallceon	22	5	10
Heptageniidae	15		1
Leucrocuta	20	8	
Procloeon		3	5
Pseudocloeon	1		8
Stenacron	8	16	
Stenonema femoratum		2	
Tricorythodes		5	1
HEMIPTERA			
Corixidae		1	1
Microvelia			2
ISOPODA			
Lirceus	58	9	56
LUMBRICINA			
Lumbricina	4	-99	
LUMBRICULIDA			
Lumbriculidae	1		
NEOTAENIOGLOSSA			
Elimia	5		
ODONATA			
Argia			1
Boyeria			-99

Aquid Invertebrate Database Bench Sheet Report**MacDougal Cr [132017], Station #1b, Sample Date: 9/25/2013 8:45:00 AM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Calopteryx			3
Gomphidae	3		
Hetaerina		1	2
Stylogomphus albistylus		-99	
PLECOPTERA			
Acroneuria	2	-99	
Agnetina capitata	7		
Perlesta	28		1
Zealeuctra	5		1
TRICHOPTERA			
Ceratopsyche morosa grp	2		
Cheumatopsyche	158		21
Chimarra	26		
Helicopsyche	15		
Polycentropus	3		1
Rhyacophila	1		
TRICLADIDA			
Planariidae	51	1	18
TUBIFICIDA			
Ilyodrilus templetoni		1	
Limnodrilus hoffmeisteri		4	
Tubificidae		39	
VENEROIDA			
Pisidiidae	1	10	

Aquid Invertebrate Database Bench Sheet Report**Washburn Hollow [132018], Station #1, Sample Date: 9/25/2013 12:05:00 PM****CS = Coarse; NF = Nonflow; -99 = Presence**

ORDER: TAXA	CS	NF
"HYDRACARINA"		
Acarina	1	1
BASOMMATOPHORA		
Physella	3	-99
COLEOPTERA		
Lioporeus	2	5
Psephenus herricki	1	
DECAPODA		
Orconectes virilis		-99
DIPTERA		
Ablabesmyia		2
Microtendipes		4
Natarsia		1
Parametriocnemus	1	
Pentaneura	1	1
Polypedilum aviceps	12	
Polypedilum tritum	2	1
Stictochironomus		1
Tanytarsus		1
Thienemannimyia grp.	11	
Zavrelimyia	2	3
EPHEMEROPTERA		
Acentrella	2	
Baetis	12	
Centroptilum		3
Diphetor	19	
Leucrocuta	17	23
Stenonema femoratum	7	60
HEMIPTERA		
Trepobates		1
ISOPODA		
Lirceus	643	218
PLECOPTERA		
Leuctridae	4	3
Perlidae	1	
TRICHOPTERA		
Cheumatopsyche	1	
Polycentropus		1
TRICLADIDA		

Aquid Invertebrate Database Bench Sheet Report

Washburn Hollow [132018], Station #1, Sample Date: 9/25/2013 12:05:00 PM

CS = Coarse; NF = Nonflow; -99 = Presence

ORDER: TAXA	CS	NF
Planariidae	2	1
TUBIFICIDA		
Tubificidae		1

Aquid Invertebrate Database Bench Sheet Report**North Fk Spring R [132019], Station #11, Sample Date: 9/25/2013 2:35:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
"HYDRACARINA "			
Acarina	1	29	1
ARHYNCHOBDELLIDA			
Erpobdellidae	1	9	1
BASOMMATOPHORA			
Ancylidae	24	5	9
Helisoma	1		3
Menetus			12
Physella			1
COLEOPTERA			
Dubiraphia		1	1
Psephenus herricki	3		
Scirtidae	1		
Stenelmis	88	6	4
DECAPODA			
Orconectes neglectus	-99		
DIPTERA			
Ablabesmyia	2	42	18
Ceratopogoninae		10	
Chironomidae	2		2
Chironomus		1	
Cladopelma		1	
Corynoneura	6		
Cricotopus bicinctus	3		1
Cricotopus/Orthocladius	3	3	2
Cryptochironomus		2	
Cryptotendipes		3	
Dicrotendipes		17	5
Diplocladius	3		
Labrundinia	1	2	6
Micropsectra	1		8
Nanocladius	1	7	12
Nilothauma			3
Parachironomus			1
Parametriocnemus	3		1
Paratanytarsus	1	5	32
Paratendipes	3	12	4
Phaenopsectra	2	3	1
Polypedilum convictum	123		1
Polypedilum halterale grp		3	

Aquid Invertebrate Database Bench Sheet Report**North Fk Spring R [132019], Station #11, Sample Date: 9/25/2013 2:35:00 PM****CS = Coarse; NF = Nonflow; RM = Rootmat; -99 = Presence**

ORDER: TAXA	CS	NF	RM
Polypedilum illinoense grp	61	2	5
Polypedilum scalaenum grp	4	1	1
Procladius		19	
Rheocricotopus	2		
Rheotanytarsus	17		2
Simulium	5		
Stempellinella	12	1	1
Stenochironomus	3	2	
Tanytarsus	80	62	115
Thienemanniella	9		
Thienemannimyia grp.	11		5
Tribelos		1	2
EPHEMEROPTERA			
Baetis	1		
Caenis latipennis	1	6	10
Hexagenia limbata		6	
Stenonema femoratum	8	12	
HEMIPTERA			
Microvelia	1		
MEGALOPTERA			
Sialis		2	
ODONATA			
Argia	6	4	11
Calopteryx	5		5
Enallagma			17
Gomphidae	1		
Macromia			1
RHYNCHOBDELLIDA			
Glossiphoniidae			1
TRICHOPTERA			
Cheumatopsyche	78	1	1
Chimarra	8		
Hydroptila		1	
Oecetis		6	
TRICLADIDA			
Planariidae	13	1	
TUBIFICIDA			
Tubificidae	22	106	3
VENEROIDA			
Corbicula	14	14	5

Appendix D

Missouri Department of Conservation Fish Data

MDC Fish Data				
Station	Date (2013)	Number of Species	MO Criteria	MO Criteria Class
Trib. Silver Cr. #1	June 25	6	13	Highly Impaired
Trib. Silver Cr. #2	June 25	3	9	Highly Impaired
Trib. Silver Cr. #3	June 26	3	9	Highly Impaired
Trib. Joplin Cr. #1	June 27	2	13	Highly Impaired
Trib. Joplin Cr. #2	June 26	3	17	Highly Impaired
Trib. Joplin Cr. #3	June 26	4	13	Highly Impaired
Trib. Joplin Cr. #4	June 25	2	11	Highly Impaired
Trib. Joplin Cr. #5	June 25	2	9	Highly Impaired
Trib. to Trib. Joplin Cr.	June 26	1	9	Highly Impaired
MacDougal Br.	July 17	11	27	Highly Impaired
Trib. to Elm Spring Br.	July 1	5	15	Highly Impaired
WH	July 10	*	*	*
Motley Br.	July 17	*	*	*
N. Fork Spring R. #11	July 15	24	45	Not Impaired

*Dry or nearly dry, not sampled for fish

MDC Fish Species Composition		
Station	Fish Species (Common Name)	Total Count
Trib. Silver Cr. #1	Central Stoneroller	58
	Western Mosquitofish	17
	Stippled Darter	6
	Spotted Bass	1
	Green Sunfish	60
	Bluegill	6
Trib. Silver Cr. #2	Creek Chub	1
	Central Stoneroller	1
	Western Mosquitofish	3
Trib. Silver Cr. #3	Creek Chub	1
	Central Stoneroller	16
	Western Mosquitofish	4
Trib. Joplin Cr. #1	Central Stoneroller	108
	Green Sunfish	82
Trib. Joplin Cr. #2	Central Stoneroller	299
	Western Mosquitofish	5
	Green Sunfish	130
Trib. Joplin Cr. #3	Cardinal Shiner	3
	Central Stoneroller	41
	Western Mosquitofish	12
	Green Sunfish	5
Trib. Joplin Cr. #4	Central Stoneroller	184
	Western Mosquitofish	42
Trib. Joplin Cr. #5	Central Stoneroller	4
	Western Mosquitofish	1
MacDougal Br.	White Sucker	3
	Northern Hog Sucker	1
	Redspot Chub	6
	Creek Chub	40
	Southern Redbelly Dace	156
	Cardinal Shiner	115
	Central Stoneroller	46
	Western Mosquitofish	1
	Northern Orangethroat Darter	11
	Barred Fantail Darter	49
	Banded Sculpin	91

MDC Fish Species Composition (continued)		
Station	Fish Species (Common Name)	Total Count
Trib. to Elm Spring Br.	Creek Chub	53
	Southern Redbelly Dace	220
	Northern Orangethroat Darter	3
	Barred Fantail Darter	11
	Banded Sculpin	16
N. Fork Spring R. #11	Spotted Gar	1
	Spotted Sucker	1
	Black Redhorse	26
	Golden Redhorse	4
	Creek Chub	9
	Western Redfin Shiner	38
	Bigeye Shiner	192
	Ozark Minnow	92
	Bluntnose Minnow	154
	Central Stoneroller	214
	Black Bullhead	1
	Yellow Bullhead	1
	Blackstripe Topminnow	177
	Western Mosquitofish	3
	Johnny Darter	7
	Northern Orangethroat Darter	61
	Arkansas Darter	10
	Barred Fantail Darter	76
	Largemouth Bass	9
	Green Sunfish	77
	Orangespotted Sunfish	1
	Longear Sunfish	203
	Bluegill	69
	Brook Silverside	8